LOAN DOCUMENT

PHOTOGRAPH THIS SHEET

AD-A271 167

DTIC ACCESSION NUMBER

LEVEL

(1)

INVENTORY

ASC-TR-93-5011

DOCUMENT IDENTIFICATION

1 Aug 93

DISTRIBUTION STATEMENT A

Approved for public release

Distribution Unlimited

DISTRIBUTION STATEMENT

H A N D L E W I T H C A R E

ACCESSION FOR

NTIS	GRA&I	☑
DTIC	TRAC	☐
UNANNOUNCED		☐
JUSTIFICATION		

BY

DISTRIBUTION/

AVAILABILITY CODES

DISTRIBUTION	AVAILABILITY AND/OR SPECIAL	
A-1		

DISTRIBUTION STAMP

DTIC ELECTE OCT 2 6 1993 S C D

DATE ACCESSIONED

DATE RETURNED

93 10 8 152

DATE RECEIVED IN DTIC

REGISTERED OR CERTIFIED NUMBER

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-FDAC

DTIC FORM 70A JUN 90

DOCUMENT PROCESSING SHEET

LOAN DOCUMENT

93-23998

ASC-TR-93-5011

DESIGN-BUILD-OPERATE:

Technologically Superior U.S. Military Forces through a New Approach to Maintaining U.S. Industry's Aerospace Technology Leadership

Prepared by the Working Panel: Technical Strategy for the Industrial Base

1 August 1993

Published by: Development Planning Directorate
Aeronautical Systems Center
Air Force Materiel Command
Wright-Patterson AFB, OH 45433-7016

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely Government-related procurement, the united States Government incurs no responsibility or any obligation whatsoever. The fact that the government may have formulated or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication, or otherwise in any manner construed, as licensing the holder, or any other person or corporation; or as conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way to related thereto.

This report is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

Bernard A. Schneider

BERNARD A. SCHNEIDER
Development Planner
Integration Branch
Studies and Analysis Division
Directorate, Development Planning

R. L. Haas

RAYMOND L. HAAS, SES
Chief, Studies and Analysis Division
and Director of Engineering
Directorate, Development Planning

John M. Griffin

JOHN M. GRIFFIN, SES
Director, Development Planning

James A. Fain Jr.

JAMES A. FAIN, JR.
Lieutenant General, USAF
Commander

If your address has changed, if you wish to be removed from our mailing list, or if the addressee is no longer employed by your organization please notify ASC/XREI, Wright-Patterson AFB, OH 45433-7016 to help us maintain a current mailing list.

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

JUL 1993 FINAL 03/01/93--07/30/93

DESIGN-BUILD-OPERATOR:TECHNOLOGICALLY SUPERIOR U.S. MILITARY FORCES THROUGH A NEW APPROACH TO MAINTAINING U.S. INDUSTRY'S AEROSPACE TECHNOLOGY LEADERSHIP

DEVELOPMENT PLANNING DIRECTORATE
AERONAUTICAL SYSTEMS CENTER
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB OH 45433-7126

ASC-TR-93-5011

DEVELOPMENT PLANNING DIRECTORATE
AERONAUTICAL SYSTEMS CENTER
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB OH 45433-7126

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

To develop strategies for maintaining the design-build-operate teams in our defense industrial base, and the transfer of their technology ideas into warfighting systems, a working panel of government and industry research and development (R&D) and systems acquisition executives was formed (Working Panel: Technical Strategy for the Industrial Base) during the Chief Engineer's/Manufacturing Day with Industry held at the U.S. Air Force's Aeronautical Systems Center, Wright-Patterson AFB, Ohio, on 16-17 April 1992. Strategies were developed during August 1992 through March 1993. The "Design-Build-Operate" strategy would fundamentally restructure the defense research, development, test and evaluation (RDT&E) business. The strategy focuses on the RDT&E phase of system acquisition and provides initiatives to -1) shorten the time and decrease the cost to design and field new and improved systems, 2) exercise company/government design-build-operate teams, 3) integrate manufacturing risk reduction early, 4) emphasize continuous technology insertion, and 5) create long-term development plans.

INDUSTRIAL BASE, DEFENSE STRATEGIES, RESEARCH AND DEVELOPMENT, BUDGET STRATEGIES, AND ACQUISITION STRATEGIES 71

UNCLASSIFIED UNCLASSIFIED UNCLASSIFIED UL

DESIGN-BUILD-OPERATE:

Technologically Superior U.S. Military Forces through a New Approach to Maintaining U.S. Industry's Aerospace Technology Leadership

Prepared by the Working Panel: Technical Strategy for the Industrial Base

1 August 1993

CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACC	Air Combat Command
Acft	Aircraft
AFB	Air Force Base
APEX	Acquisition Process Excellence
ASC	Aeronautical Systems Center
ATD	Advanced technology demonstration
CAD/CAM	Computer-aided design/computer-aided manufacturing
CAID	Clear Accountability in Design
CE&D	Concept exploration and definition
CEO	Chief executive officer
C3I	Command, control, communication and identification
DCAA	Defense Contracts Audit Agency
Dem-Val	Demonstration and validation
DoD	Department of Defense
EC	Electronic combat
EMD	Engineering and manufacturing development
Eqpt	Equipment
FAA	Federal Aviation Agency
GE	General Electric
HTIP	Hypersonic Test Investment Plan
IPD	Integrated product development
IRAD	Independent research and development
MADP	Mission area development plan
Mantech	Manufacturing technology
MDI	Manufacturing Development Initiative
MNS	Mission need statement
MS	Milestone
NASA	National Aeronautics and Space Administrations
NSIA	National Security Industrial Association
OEM	Original equipment manufacturer
OPEVAL	Operational evaluation
Pgm Mgr	Program Manager
R&D	Research and development
RDT&E	Research, development, test and evaluation
Recce	Reconnaissance
Ref	Reference
RFMETS	Radio Frequency Mobile Electronics Test Set
S&T	Science and technology
TAP	Technology area plan
TPIPT	Technical planning integrated product team
UAV	Unmanned air vehicle
U.S.	United States
X-Type	Experimental-type

1. EXECUTIVE SUMMARY

The "Design-Build-Operate" strategy would fundamentally restructure the defense research, development, test and evaluation (RDT&E) business. The strategy focuses on the RDT&E phase of system acquisition and provides initiatives to - 1) shorten the time and decrease the cost to design and field new and improved systems, 2) exercise company/government design-build-operate teams, 3) integrate manufacturing risk reduction early, 4) emphasize continuous technology insertion, and 5) create long-term development plans.

The strategy is intended to separate RDT&E decisions from a specific production commitment, and encourage the phase-in of low-rate production of new or upgraded designs. This is proposed as an implementing initiative for Secretary of Defense Les Aspin's Defense Industrial Base Strategy and is constructed to be consistent with the policies of the Department of Defense. The Design-Build-Operate strategy links the initiatives to the policies of the Air Combat Command commander, General John M. Loh and Air Force Materiel Command commander, General Ronald W. Yates.

Figure 1 summarizes the Panel's final recommendations.

Recommendations:

#1	**Publish 20 to 25-year development plans; linked to user mission area needs.**
#2	**Shift RDT&E budgets toward more mission studies, CE&D studies, technology risk reductions, Dem-Vals and EMDs (using a budget template to allocate budgets).**
#3	**Reduce time and effort to initiate RDT&E contracts.**
#4	**Eliminate low- and non-value-added government oversight. Cut government's auditing to 10% of program hours.**
#5	**Assure company ROI/ROA of 5% to 10% on RDT&E work; set profit guidelines at 15%.**

#6	**Revise manufacturing processes for low-rate production. Build small fleets of "rollover-plus" or "silver bullet" aircraft, weapons, etc.**
#7	**Preserve critical manufacturing capabilities needed for future systems.**
#8	**Offer incentives to stimulate dual-use and multi-customer products.**
#9	**Manage the private and government assets of the defense industrial base for best utilization.**
#10	**Merge government and industry models for fundamental physics studies.**
#11	**Preserve RDT&E knowledge and past lessons using an integrated network.**
#12	**Train senior government and industry decision makers on the processes used in both environments.**

Figure 1. Panel's Final Recommendations

The Panel's twelve (12) final recommendations are explained as follows:

#1. Publish multi-customer-approved mission area development plans. Use modern analysis, modeling and simulation techniques to develop 20 to 25-year plans that provide information concerning warfighters' needs and equipment deficiencies. This will focus laboratory science and technology investments and will leverage company independent research and development (IR&D) programs.

#2. Significantly increase funding early in the acquisition cycle and at the same time account for a reduced overall defense budget. Increase the number of contracts for mission studies, technology risk reductions, demonstrations, and low risk EMD programs by managing the budget process with a budget template. The purpose is to provide a larger array of potential operational solutions to a non-monolithic threat and to ensure a sound industrial base to develop those products.

#3. Develop a contracting process that will reduce the effort and consequently the time to initiate a contract. Use previously identified procedure changes (Section 800 Report; Ref 1) to FARs, DARs and policy to implement new guidance; establish a new committee to identify and change legislation. This will

implement the philosophy of annually winnowing a large number of mission studies to select only the best for concept explorations, which in turn are downselected to pursue a fewer number of demonstrations and only occasional EMDs.

NB. (The purpose of the focused development plan, the shift in funding profile and the improved contracting process is to change the emphasis of business strategy. The past strategy applies the best talent of both industry and government to the process of getting on contract. That talent should instead be focused on performing the highest quality, innovative work that is on contract, to win the narrowing selection of contracts heading toward EMD.)

#4. Eliminate non- and low-value added government oversight practices to reduce overhead costs and program cycle time. Limit government's labor hours spent on contractor oversight, surveillance and audit to 10% of total government labor hours spent on a RDT&E program. The purpose is to design, rather than inspect, quality into the acquisition process.

#5. Assure the opportunity for profit on upfront contracts. Enforce profit guidelines (typically 15%) assuring companies an opportunity to earn a return of 5% to 10% on RDT&E contracts. The purpose of this shift in emphasis is to permit profitability upfront because of the reduced production opportunities.

#6. Revise the manufacturing processes to emphasize low rate production. Using integrated product definition, manufacture (at low rate), field, operate and support small fleets of upgraded or new "rollover-plus" or "silver bullet" aircraft, weapons, or other products. Use contractor's field support as a part of the support infrastructure. The purpose is to satisfy a broader set of user needs with more types of a smaller quantity of specialized weapon systems.

#7. Preserve critical manufacturing capability for future systems. Commission a body to identify those critical manufacturing elements such as facilities, processes, and technologies necessary and determine a strategy to preserve them. The purpose is to form an integrated national strategy to avoid unknowingly eliminating key capabilities while reducing company overhead.

#8. Implement incentives to stimulate government and industry cooperation on dual-use and multi-customer products. Use contract flexibility to encourage the use of commercial products and practices whenever it lowers cost and improves quality and reduces time to market. The purpose is to encourage the use of best practices.

#9. Manage the industrial base to best use the assets of both the public and private sectors. Use industry for modification efforts that have high content of systems engineering, systems management and systems synthesis. Allocate current depot work into four categories: efforts always to be kept in the depots; efforts

always assigned to industry; effort competed for by both parties; efforts to be shared by both parties. This will define the role of the public sector as part of the industrial base.

#10. Reduce the duplication of the industry and government efforts to model fundamental physics. Form consortia to preserve, improve and standardize optimizers, analysis software and modeling and simulation techniques. This shifts proprietary efforts into innovation in design and the use of tools rather than the development of tools.

#11. Preserve the knowledge base and lessons learned for our programs. Establish a government-managed integrated data network, or library database, of systems design, engineering, integration, manufacturing and support. (Current policy demands the destruction of this crucial information.) The purpose is to share the project lessons learned across the industrial base.

#12. Provide senior level government/industry cross training. Assign selected people to work in another facility and teach each other the internal processes. The purpose is to educate executive-level decision makers on the consequence of actions and the thinking process of the customer.

2. PANEL'S RESULTS

Panel's approach:

To develop strategies for maintaining the design-build-operate teams in our defense industrial base, and the transfer of technology ideas into warfighting systems, a working panel of government and industry research and development (R&D) and systems acquisition executives was formed (Working Panel: Technical Strategy for the Industrial Base) during the Chief Engineer's/Manufacturing Day with Industry held at the U.S. Air Force's Aeronautical Systems Center, Wright-Patterson AFB, Ohio, on 16-17 April 1992.

Five guiding principles were agreed to by the panel members and used as a framework in establishing strategies:

1) A strategy is needed to assure the continued superiority of U.S. armed forces.
2) The strategy should implement national policies for maintaining the defense industrial base.
3) The strategy should support industry's capabilities to design, develop, manufacture and support technologically-superior systems.
4) The strategy should avoid creating a "subsidized" segment of the national economy.
5) The strategy should provide competitive opportunities for companies to profitably engage in defense RDT&E and prevent serious damage to the industrial base supporting the Air Force's Product Centers and Logistics Centers.

The Panel examined ways to fundamentally restructure the defense research, development, test and evaluation (RDT&E) business; not just develop strategies facilitating a shrinkage of the current structure. Figure 2 summarizes their aims.

Panel's Aims:

Applying continuous technology insertion.
Focusing long-term development planning.
Integrating manufacturing risk reduction early.
Exercising company teams more often.
Shortening time, decreasing cost to design and field systems.

Figure 2. Panel's Aims

Their improvements were aimed at:

: applying continuous technology insertion to impact the quality of warfighting forces,
: focusing long-term development planning,
: integrating manufacturing risk reduction early,
: exercising company design-build-field teams more often, and
: shortening the time and decreasing the cost to design and field new and improved systems.

The Panel's new "Design-Build-Operate" strategy implements the DoD's resource strategy for the industrial base. It provides for design, development and operation of new technology capabilities for upgraded and new systems. These provide the basis for selected low-rate production in limited or full quantities.

The strategy is intended to produce technologically-superior equipment for our operational forces. It calls for actions to increase the DoD's activity levels for technology development (with particular emphasis on dual-use technologies), concept exploration, concept demonstration and validation, and engineering and manufacturing development. It also recommends that RDT&E activity be decoupled from a production commitment. Company design-build-operate teams need a continuous flow of profitable new work in order to maintain their presence and skills. They need competitive opportunities to design, develop, build, operate and support upgraded and new systems.

The strategy reflects the policies and goals of the Clinton Administration and Secretary of Defense Les Aspin. The implementation is subject to direction from the Department of Defense and Headquarters, Air Force and funding constraints.

New-start projects and programs would result from needs expressed in the operating commands' mission need statements (MNSs) and the 20 to 25-year mission area development plans (MADPs). The Budget Template is intended to allocate dollars for systems RDT&E, and is not intended to impact budgets for science and technology development (S&T) nor systems operation and support (O&S).

The Panel's approach satisfies the warfighter's needs for upgraded and new systems employing innovative ideas and technologies. They are given opportunities to evaluate new and improved products and operational capabilities using their planned warfighting strategies.

Panel's assessment of the future:

During peacetime and austere budgets (see Appendix for budget data), the Department of Defense (DoD) must continue to build and field warfighting systems that are technologically superior to those available to potential enemies.

In future scenarios, U.S. forces will be facing first-rate weapons in third world environments. Countries will be able to purchase high-technology systems enabling them to make strategic gains during quick aggressive moves. In this environment, our forces must maintain world leadership in technologies and equipment.

During the Cold War, the Soviets continually built and fielded new weapons and aircraft, forcing us to match each new threat with a new fleet of offensive and/or defensive systems. We used technologically superior systems to match their numerically superior forces. Tomorrow we may be called upon to fight in one or more of many diverse regional conflicts; each with it's unique scenario, threat, and required U.S. response (tactics, force structures, and warfighting hardware). We will need a wide variety of warfighting capabilities, including an assortment of specialized systems.

Statements made by Secretary of Defense Les Aspin indicate the nature of future dangers to U.S. security, and the strategies that may be employed to maintain our defense industrial base to meet those challenges: (Refs 2,3)

"I think the challenges we will face together fall basically into two categories ..... maintaining the superb quality of our forces and the high technology advantage ..... (and) dealing with the dangers we face in this fast changing, post-Cold War, post-Soviet world."

"Four dangers have emerged that concern us today ..... the new nuclear danger ..... regional conflicts ..... possibility of a failure of reform, particularly in the former Soviet Union ..... (and) failure to see our national security interests in a way that includes the economy. Economic well-being is vital to our security."

"The resource strategy I want you to consider has four parts: 1) selective upgrading, 2) selective low-rate procurements, 3) rollover plus, and 4) silver bullet procurements."

"Selective upgrading: Critical portions of the production base for certain items can be maintained by upgrading systems or subsystems. Upgrading allows us to improve our capabilities where new systems aren't needed and can't be afforded."

"Selective low-rate procurements: ..... a sustaining rate of procurement even if it exceeds our short-term needs."

"Rollover-plus: ..... would continue to prototype new systems and components but not put them into production until stringent criteria are met. Those criteria are - a) that the technology works, b) that it was required by development of the threat, or c) represented a breakthrough that would alter battlefield operations. The resultant prototype must be "production-

representative", and thoroughly tested in an operational context."

"Silver bullet procurements: ..... highly capable systems procured in limited quantities and reserved for operations where a high-tech advantage could maximize U.S. leverage."

The vitality of our defense product teams must be a central core of any budget strategy. They need opportunities to hone their skills, train new members, and apply their ideas on new military equipment. (Ref 4)

Companies should assist the warfighters and DoD product center in accomplishing mission area assessment studies, and should help in developing technology options. They should witness field trials to learn the strong and weak points in their product designs.

Many innovations in commercial products have been spawned by results from DoD-funded research and technology development. Materials, electronics, engines, design tools, and manufacturing processes are among the examples. Similarly, commercial technologies and products have been successfully applied to military hardware and software. Therefore, new defense industrial base strategies should foster close coupling of government and commercial research and development (R&D), and the application of products in both spheres.

As described by General Ronald W. Yates, Commander, Air Force Materiel Command: (Ref 5)

"Advanced technology ..... is the vital underpinning of the contributions of the Air Force to national security in the future."

"Technology transfer is where our focus on hi-tech meets our need to help maintain the economic leadership our nation needs. ..... national strength is based as much on economic strength as on military might."

The military viewpoint:

National military strategy is built on four foundations: strategic deterrence and defense, forward presence, crisis response, and reconstitution. The U.S. Air Force's Global Reach - Global Power role for aerospace power is based on certain core capabilities (Ref 6; Air Force Planning Guidance):

: maintain global situational awareness,
: inflict paralysis of the adversary by striking key targets,
: assure access to regions of national interest,
: hold strategic targets at risk, while defending against missiles,
: deploy sufficient quality forces worldwide to conduct operations,
: assist international and humanitarian efforts,
: sustain research and industrial base to keep a technological edge,
: accomplish a full range of tasks to support the warfighters.

While reshaping our national defense policy, we are performing the most significant restructuring of the DoD in recent times. The current DoD drawdown will reduce the total obligation authority of $361 billion in 1985 to $271 billion in 1993, to $253 billion in 1998, with more cuts to follow. By 1998, we will be spending 57 cents of every tax dollar on Medicaid, Medicare, and Social Security, and only about 14 cents on defense. That is less than we plan to pay for interest on the national debt - 16 percent. (Ref 7) The DoD's 3% share of the nation's gross national product projected for fiscal year 1998 will be lower than post-World War II.

Recent remarks by General John M. Loh, Commander, Air Combat Command (ACC): (Ref 8)

> *"We need to reduce the cost of ownership and increase or alter performance to help existing systems cope with the new threat landscape and regional environments."*
>
> *"We should always plan and fund for low rate (production) in the future, not high*

rate. We must keep a viable competitive domestic industrial base."

"I see a "rollover-plus" prototype as an advanced operational prototype which includes the latest state-of-art systems. It also includes the development of manufacturing technologies, with all the producibility elements incorporated."

"I define silver bullets as those systems that exploit leap-frog technologies ..... they are needed in relatively few quantities."

"I believe we should look at an acquisition strategy based not only on the threat ..... (also) on replacement of existing force structure. We need to combat technical obsolescence, improve the cost of ownership, and maintain a globally competitive industrial base."

Final recommendations:

See EXECUTIVE SUMMARY; Panel's final recommendations.

Panel's "Design-Build-Operate" strategy:

The Working Panel's "Design-Build-Operate" strategy has nine (9) elements, summarized in Figure 3.

<u>Nine Elements of "Design-Build-Operate" Strategy:</u>

1. Numerous pre-Milestone 0 mission need studies each year, used to formulate the 20 to 25-year mission area development plans (MADPs).

2. Numerous competitive CE&D contracts each year, seeking cost-effective 80% solutions to needs identified in the MADPs.

3. Numerous competitive Dem-Val projects each year, selected from successful, desirable CE&D results.

4. Several EMD contracts each year, across product lines, responding to priority needs of the warfighters. These develop products resulting from prior successful Dem-Val efforts.

5. Low-rate manufacturing of small fleets of upgraded or new systems for long-term field trials and military contingencies.

6. Simple procedures to terminate unsuccessful or unneeded RDT&E efforts.

7. Profit guidelines (typically 15%) to assure reasonable return on investments and assets for companies involved in RDT&E.

8. Strong industry participation in overhaul, maintenance and modification work for current fielded systems.

9. Flexible government management of RDT&E (rebalancing) to respond to changes in technical objectives, funding and schedules.

Figure 3. Nine Elements of "Design-Build-Operate" Strategy

The elements of the strategy are explained as follows:

1) A wide assortment of pre-Milestone 0 mission need study contracts awarded each year by each defense product center; derived from the long-term mission area development plans (20 to 25 years) that meet the needs of the warfighting commands. The

development plans, formulated for broad mission areas, describe the results of strategy-to-task and task-to-need efforts by the warfighting commands, using analysis support from product center contracts and in-house efforts. They also describe a set of potential solutions, prioritized according to their relative operational payoff, technology maturity, and developmental risk. (Ref 9) Efforts to pursue these solutions are "roadmapped" into a 20 to 25-year course of action for product center RDT&E and system acquisitions.

2) Numerous competitive Phase 0 concept exploration and definition (CE&D) study contracts awarded each year by each product center pursuing alternative cost-effective solutions to the needs identified in the product center's development plans. These contracts typically pursue 80% solutions to mission needs (in the interest of reducing costs and schedules), and would deliver technology products, brassboard or breadboard systems or product designs with material specifications, cost and operational effectiveness analysis results, and initial design-build-operate-support models with simulations for "ilities", integrated product development, and integrated logistics support. These contracts would generate yearly opportunities for companies to perform innovative CE&D work, to exercise their design teams, and to implement new technologies. They could also be used to develop and mature promising acquisition processes, such as the Manufacturing Development Initiative, lean manufacturing, and activity-based accounting techniques.

3) Numerous competitive demonstration and validation (Dem-Val) contracts awarded each year by each product center, selected from the most highly successful and desirable CE&D efforts. These contracts provide for the design and development of the high-risk "pieces" of a new or improved system or product. They are awarded for the purposes of risk reduction of new technology products, evaluation of product design concepts, or evaluation of engineering brassboards prior to full-up design-build-operate-test of a complete vehicle during EMD. While some Dem-Val hardware and software would be taken by the developing team to the using command operational sites for extensive operational evaluation, these products are generally not suited for long-term user ownership. Only rarely should Dem-Val contracts provide complete new flying pre-production prototypes; only when flight testing must be used in lieu of modeling and simulation of the system. The use of flying prototypes is not a programmatic

acquisition strategy preferred by the Working Panel; it rarely is successful in reducing technology risk.

4) Several EMD contracts awarded each year, affecting each of the major product lines of the product center and the needs expressed by the warfighting commands. New EMDs would be selected from highly successful and desirable Dem-Val efforts. They could blend the results of several unrelated but successful risk reduction efforts in prior Dem-Vals. They provide companies with opportunities to maintain their full-capability, integrated product teams. The company's full range of R&D, design, concurrent engineering/IPD, integration, manufacturing process development, field testing and support capabilities would be exercised. These EMDs are not necessarily tied to a production commitment. A few preproduction vehicles or products are delivered for field trials, user effectiveness evaluations, and tactics development. They remain indefinitely with the user for continued long-term utilization and evaluation. In addition to fielding new or improved vehicles, support equipment, and training kits, the EMD contracts would deliver a simulation model of the future production build-to, support-to packages with cost estimates.

5) Manufacture (in low-rate production), field, operate and support small fleets of upgraded or new military systems. Use these to try new warfighting technologies, new operational concepts and tactics, or improvements to maintenance and support of current systems. Let the contractor provide test, operational and maintenance support. Advantages to this strategy are: 1) having superior warfighting systems on hand for military contingencies, 2) exercising the company's full range of design, production and support capabilities, 3) permitting the military to develop tactics for using the product, 4) exercising a field support and deployment plan for the product, 5) demonstrating the effectiveness of new technologies, 6) exercising the supplier base for the company, and 7) maintaining the industrial base for the military's product center.

6) Establish simple procedures to terminate RDT&E efforts when the military user's need has evaporated, when the concept or technology is found to be not beneficial during evaluations, or when an alternative, more cost-effective solution emerges. In order to promote innovative R&D and the occasional development of high-risk,high-payoff concepts, there should be no stigma or financial penalty attached to the cancellation of R&D programs and the termination of contracts. That is, "failure" can be an outcome when high-risk, high-potential payoff endeavors are

attempted. Special procedures should govern the management of high-risk ventures.

7) Establish profit guidelines (typically 15%) on government RDT&E contracts that will permit companies to earn a reasonable return on their investments and assets for all types of RDT&E work, including laboratory-funded science and technology development. With a lessened promise of production, the government should not expect companies to perform development work at minimal profit in an effort to favorably posture themselves for a big, long production run.

8) Provide for strong industry participation in the overhaul, maintenance and modification work for current fielded systems. This work helps to maintain their capabilities, facilities, experience, training and people. It affords opportunities to exercise multidisciplinary integrated product development and engineering, and employs the factory floor. Although companies do not expect to make significant revenues and profits on this work, it improves their overhead cost and indirect cost bases by contributing to a higher volume of direct labor hours and materials.

Decisions for placing depot support work in the public or private sectors should consider dividing this work into three categories: 1) work that should always go to industry, 2) work that should always stay in the depot, and 3) work that should be competed between the public and private sector. Work contracts that should always go to industry are those that involve systems and equipment modifications that have significant systems engineering/systems integration/systems management/systems synthesis content. These are essential areas for U.S. companies to maintain worldwide leadership. In the second category, depot infrastructure should be maintained for reverse engineering and maintenance of older weapon systems for which no contractor support team is being maintained. This can be an unattractive area for industry; therefore, there is high risk of having adequate support capability disappear. In category three, all of the remainder of the work should be considered for competition.

9) Provide for flexible government management of RDT&E contracts to permit technical objectives, funding and schedules to be adjusted or rebalanced to fit the needs of the project. Make the government implement its responsibility to continuously balance the level of the requirements in consort with the risk to the design. Continue to improve government

management procedures and contract requirements that will permit the government's program manager to adjust technical, cost and schedule requirements of a RDT&E effort to meet changing conditions. The government and the contractor should continually assess the technical, cost and schedule objectives and progress in order to determine whether mid-course corrections are needed. Then the government should respond quickly to needed changes by adjusting the contract's funding, schedule, or technical requirements.

There should be considerable interaction between the government and industry <u>before</u> the technical, cost, and schedule requirements for a system development are settled. This insures that goals will be consistent with limited budgets, and that the government's expectations are realistic.

"Budget Template" implementing the "Design-Build-Operate" strategy:

As a member of the Working Panel, the Directorate of Development Planning (ASC/XR) at the U.S. Air Force's Aeronautical Systems Center (ASC) at Wright-Patterson AFB, Ohio applied the Panel's "Design-Build-Operate" strategy by creating illustrative "Budget Templates" for future ASC RDT&E. These describe budgets and schedules for a substantial yearly volume of competitive contracts for upgraded and new products, and they address warfighter's needs expressed in the development plans.

The Panel's strategy for the template requires each competitive step of RDT&E to proceed from the successful results of the prior step. Therefore, ASC's entire RDT&E program would be generated by the broad mission area development plans generated by the Technical Planning Integrated Product Teams (TPIPTs).

Constraints on the budgets and schedules for Dem-Val and EMD demand that these program phases be efficient, quick and fully-funded. Funding for each project must be stabilized to avoid perturbations which will upset the budget and schedule. Likewise, it suggests a commitment to stabilize the product center's long-term business plan and funding.

Product designs must be carefully focused with well-constructed technical, cost and schedule requirements. During a project, the government must be prepared to rebalance cost, schedule and technical objectives as the need arises in order to follow the template's budget and schedule guidelines. To facilitate leaner, quicker development, companies must be very cost-conscious, and must use streamlined engineering techniques such as concurrent engineering, IPD, paperless design, modern design tools and modeling, simulation, and analyses.

The template approach is described as follows:

1) Background: ASC's biennial six-year RDT&E budget is prepared by melding diverse inputs from system program offices, functional organizations, Wright Laboratory, the development planners (ASC/XR), and others. New work is often added onto an existing RDT&E program. This process does not result in a 20 to 25-year budget outlook. The budget significantly changes in each new version, and each tapers off during its six-year period. Presently, large portions of the Center's RDT&E dollars are tied to lengthy, complex programs. In the FY93 budget of $5.8 billion (including $700 million for Wright Laboratory's science and technology work), three major aircraft programs (F-22, B-2 and C-17) are spending $3.4 billion. (Ref 10)

2) Three templates were developed, illustrating the flexibility of this tool to govern RDT&E:

Template #1: $4.8 billion annual RDT&E budget (approximating ASC's current annual budget devoted to product development). It produces 145 products per decade, including ten aircraft EMDs.

Template #2: $2.8 billion, also producing 145 products per decade, including ten aircraft EMDs. It illustrates the potential impact of reducing a project budget below a level which will produce a useful product.

Template #3: $2.8 billion, producing 92 products per decade, including six aircraft EMDs, with individual project budgets similar to Template #1 (i.e., equivalent program content).

3) For Template #1, the assumed ASC budget of $4.8 billion was allocated as follows:

Product		Template #1 Yearly RDT&E ($$ FY93 billions)
Aircraft:	Tactical	
	Bomber	
	Cargo & Tanker	
	Electronic	
	Trainer	
	Other-Utility	
	X-Type	
	subtotal =	$3.30 billion
UAVs:	All types	$0.15
Missiles:	Ballistic	$0.10
	Cruise	$0.10
Munitions:	Bombs	$0.10
	General	$0.05
Engines:	Aircraft	$0.30
	Missile	$0.10
Other Sub-systems:	Electronic Pods	$0.10
	Simulators	$0.10
	General Aircraft	$0.10
	Electronic Combat & Recce	$0.10
	Avionics	$0.10
	Support Eqpt	$0.10
	Total =	$4.80 billion

4) The following schedule constraints were universally applied:

: mission need studies	one-year studies
: CE&E studies	two-year studies
: Dem-Vals	three-year projects
: EMDs	four-year programs

5) At the start, ASC/XR examined the DoD's aircraft development from 1960 to 1994. (Ref 11) Peak periods were 1965-1969 with 11 aircraft designed and flown, and 1980-1984 with 10 aircraft (suggesting a rate of 20-22 aircraft per decade). Worst periods were 1960-1964 with 4 aircraft, and 1985-1989 with 3 aircraft (suggesting a rate of 6-8 aircraft designs per decade). A panel of experts at ASC (Ref 4), and a recent RAND report (Ref 12), suggested 1-1/2 to 2 design-and-fly programs per decade for

the DoD's industrial base of design teams. Without debating how many companies it would support, ASC/XR chose an EMD rate of 10 aircraft per decade for Template #1. This rate is illustrated in Figure 4 and is included in the following list of product EMDs for Template #1:

Product		Quantity of New or Improved Products per Decade
Aircraft:	Tactical	2
	Bomber	1
	Cargo and Tanker	2
	Electronic	2
	Trainer	1
	Other - Utility	2
	X-Type	2 (laboratory funded)
UAVs:	All types	2
Missiles:	Ballistic	1
	Cruise	1
Munitions:	Bombs	2
	General	2
Engines:	Aircraft	2
	Missile	2
Other Subsystems:	Electronic pods	3
	Simulators & trainers	10
	General aircraft	30
	Elec Combat & Recce	30
	Avionics	30
	SE & AGE	30
	Total =	145 EMD'd products; plus 2 laboratory X-type aircraft

6) Figure 4 lists the allocated budget for each step of development for each product. To complete one (1) tactical aircraft development in the line entitled "Aircraft - Tactical", the template describes the following activity:

: 12 competitive, one-year mission need studies at $2 million apiece,

: 3 competitive, two-year CE&D studies, each costing $20 million per year (selected from among the successful results of the mission need studies),

: 1 or 2 competitive, three-year Dem-Val projects, each costing $250 million per year (selected from among the successful results of the CE&D studies), and

: 1 competitive, four-year EMD program, costing $500 million per year.

: Thus, the tactical aircraft development would be allocated approximately $2.9 billion to $3.6 billion.

: In some cases, portions of the budgets for engines, avionics, simulators and trainers, and support equipment could be added to an aircraft development if they are considered to be an integral part of the aircraft system.

7) Figure 5 shows ASC's long-term RDT&E budget profile as the new "design-build-operate" strategy is implemented starting in FY94. It would be fully engaged by the year 2003, thereafter stabilizing the budget at $4.8 billion per year.

8) For Templates #2 and #3, the assumed ASC budget of $2.8 billion was allocated as follows:

Product		Templates #2 & #3 Yearly RDT&E ($$ FY93 billions)
Aircraft:	Tactical	
	Bomber	
	Cargo & Tanker	
	Electronic	
	Trainer	
	Other-Utility	
	X-Type	
	subtotal =	$2.00 billion
UAVs:	All types	$0.08
Missiles:	Ballistic	$0.06
	Cruise	$0.06
Munitions:	Bombs	$0.06
	General	$0.04
Engines:	Aircraft	$0.15
	Missile	$0.05
Other Sub-systems:	Electronic Pods	$0.05
	Simulators	$0.05

Gen'l Aircraft		$0.05
EC & Recce		$0.05
Avionics		$0.05
Support Eqpt		$0.05
	Total =	$2.80 billion

9) Figures 6 and 7 show Template #2. Although it shows ten (10) aircraft EMDs per decade, the allocated budget for each has been reduced to $1.75 billion. Similar budget cuts were allocated to other products in the template, reflecting a 40% across-the-board reduction from Template #1. The immediate question may be whether or not these budgets are adequate to generate useful products.

10) Figures 8 and 9 show Template #3. Six aircraft EMDs are completed per decade within a total budget of $2.8 billion per year. The cost of a product development is roughly the same as Template #1. Lower rates of development were applied across all product lines, resulting in 92 products per decade.

These templates illustrate the flexibility of this tool to govern a product center's RDT&E activity. It can be adjusted to the size of the total budget, the number of programs, or both. It reflects three main concerns - 1) the need for more activity in mission need studies, CE&Ds, Dem-Vals and EMDs, 2) the danger of cutting budgets below levels that prevent meaningful technical progress toward satisfying future needs for upgraded and new capabilities, and 3) the needed rate of competitive opportunities for companies to maintain their design-build-field teams.

Panel members urged an RDT&E budget of $5.5 billion for ASC ($0.7 billion for Wright Laboratory and $4.8 billion for product development) in order to generate the RDT&E activity of Template #1. An output of 145 upgraded and new products per decade within this budget should strike a good balance between: 1) satisfying user needs, 2) inserting new technologies, 3) maintaining the proficiencies and capabilities of the Center's industrial base, 4) providing adequate technical progress within the cost and schedule constraints of the budget allocations, and 5) providing the basis for selecting some upgraded and new products for low-rate production.

		Mission Need Studies (1yr)		Concept Development (2yrs)		Dem-Vals (3yrs)		EMDs (4yrs)	
		Qty	Cost/Yr	Qty	Cost/Yr	Qty	Cost/Yr	Qty	Cost/Yr
Aircraft:	Tactical	24	$2.00	6	$20.00	3	$250.00	2	$500.00
	Bomber	9		3		1		1	
	Cargo & Tanker	16		4		2		2	
	Electronic	20		6		2		2	
	Trainer	12		4		2		1	
	Other-Utility	24		8		3		2	
	X-Type	10		8		2		0	
	Subtotal	115		39		15		10	
UAVs:	All	64	$0.50	16	$2.50	4	$25.00	2	$100.00
	Subtotal	64		16		4		2	
Missiles:	Acft Ballistic	12	$2.00	6	$5.00	2	$50.00	1	$200.00
	Acft Cruise	12		6		2		1	
	Subtotal	24		12		4		2	
Munitions:	Acft Bombs	48	$1.00	12	$3.00	3	$30.00	2	$50.00
	Acft General	48		12		3		2	
	Subtotal	96		24		6		4	
Engines:	Aircraft	16	$1.00	8	$5.00	4	$50.00	2	$150.00
	Acft Missiles	16		8		4		2	
	Subtotal	32		16		8		4	
Other Subsystems:	Electronic Pod	54	$0.25	18	$0.75	6	$4.00	3	$6.00
	Simulators & Trainers	90		30		15		10	
	General Aircraft	360		120		40		30	
	EC & Recce	360		120		40		30	
	Avionics	360		120		40		30	
	Support Equipment	125		75		25		20	
	Subtotal	1349		483		165		123	
	Total =	1680		590		203		145	

($ FY93 millions)

Figure 4. Budget Template #1 Future ASC RDT&E

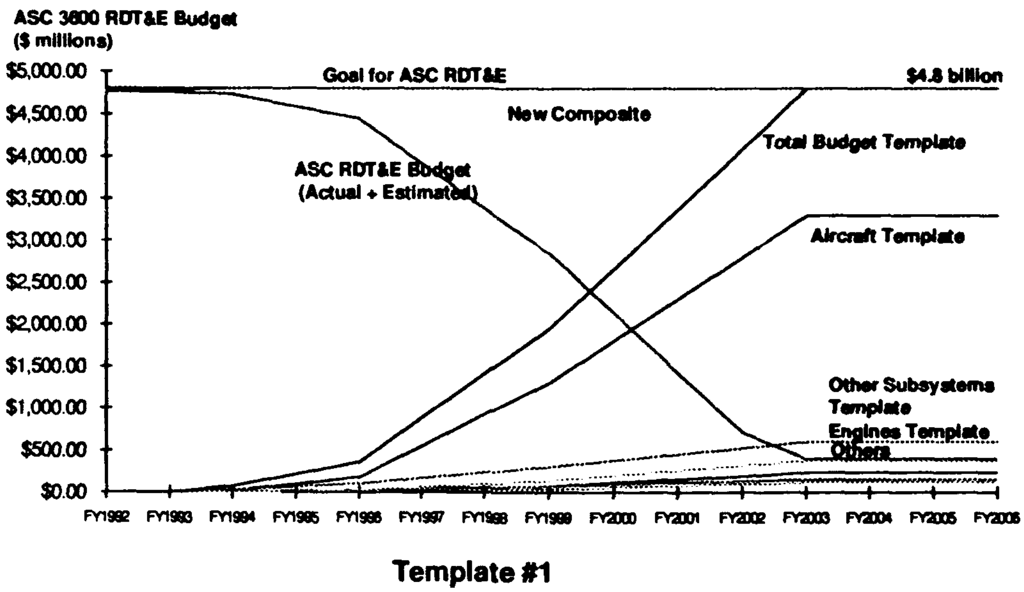

Figure 5. ASC RDT&E Total Budget Per Year ($ millions); Budget Template #1

		Mission Need Studies (1yr)		Concept Development (2yrs)		Dem-Vals (3yrs)		EMDs (4yrs)	
		Qty	Cost/Yr	Qty	Cost/Yr	Qty	Cost/Yr	Qty	Cost/Yr
Aircraft:	Tactical	24	$1.20	6	$12.00	3	$150.00	2	$300.00
	Bomber	9		3		1		1	
	Cargo & Tanker	16		4		2		2	
	Electronic	20		6		2		2	
	Trainer	12		4		2		1	
	Other-Utility	24		8		3		2	
	X-Type	10		8		2		0	
	Subtotal	115		39		15		10	
UAVs:	All	64	$0.30	16	$1.80	4	$19.00	2	$75.00
	Subtotal	64		16		4		2	
Missiles:	Acft Ballistic	12	$1.00	6	$2.50	2	$25.00	1	$100.00
	Acft Cruise	12		6		2		1	
	Subtotal	24		12		4		2	
Munitions:	Acft Bombs	48	$0.60	12	$1.75	3	$17.00	2	$28.50
	Acft General	48		12		3		2	
	Subtotal	96		24		6		4	
Engines:	Aircraft	16	$0.50	8	$2.50	4	$25.00	2	$75.00
	Acft Missiles	16		8		4		2	
	Subtotal	32		16		8		4	
Other Subsystems:	Electronic Pod	54	$0.13	18	$0.40	6	$2.00	3	$3.00
	Simulators & Trainers	90		30		15		10	
	General Aircraft	360		120		40		30	
	EC & Recce	360		120		40		30	
	Avionics	360		120		40		30	
	Support Equipment	125		75		25		20	
	Subtotal	1,340		483		166		123	
	Total =	1,680		590		203		145	

($ FY93 millions)

Figure 6. Budget Template #2 Future ASC RDT&E

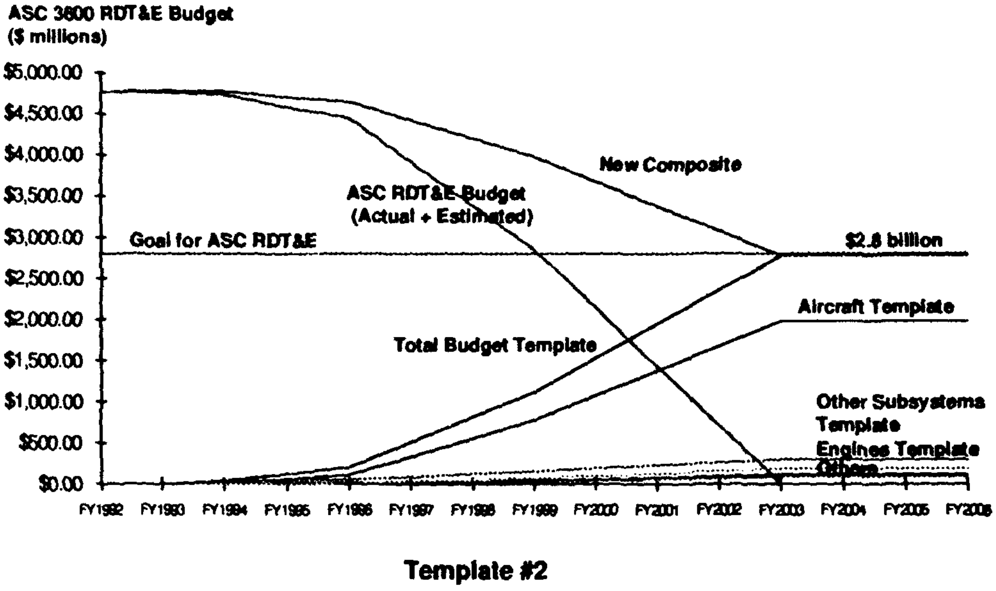

Figure 7. ASC RDT&E Total Budget Per Year ($ millions); Budget Template #2

		Mission Need Studies (1yr)		Concept Development (2yrs)		Dem-Vals (3yrs)		EMDs (4yrs)	
		Qty	Cost/Yr	Qty	Cost/Yr	Qty	Cost/Yr	Qty	Cost/Yr
Aircraft:	Tactical	24	$2.00	6	$20.00	2	$250.00	2	$500.00
	Bomber	9		3		0		0	
	Cargo & Tanker	16		4		1		1	
	Electronic	20		6		1		1	
	Trainer	12		4		1		1	
	Other-Utility	24		8		1		1	
	X-Type	10		8		2		0	
	Subtotal	115		39		8		6	
UAVs:	All	64	$0.50	16	$2.50	4	$25.00	1	$100.00
	Subtotal	64		16		4		1	
Missiles:	Ballistic	12	$2.00	6	$5.00	2	$50.00	0.5	$200.00
	Cruise	12		6		2		0.5	
	Subtotal	24		12		4		1	
Munitions:	Bombs	48	$1.00	12	$3.00	2	$30.00	1	$50.00
	General	48		12		2		1	
	Subtotal	96		24		4		2	
Engines:	Aircraft	16	$1.00	8	$5.00	2	$50.00	1	$150.00
	Missiles	16		8		2		1	
	Subtotal	32		16		4		2	
Other Subsystems:	Electronic Pod	12	$0.25	4	$0.75	2	$4.00	2	$6.00
	Simulators & Trainers	36		12		6		6	
	General Aircraft	144		48		24		20	
	EC & Recce	144		48		24		20	
	Avionics	144		48		24		20	
	Support Equipment	96		32		16		12	
	Subtotal	576		192		96		80	
	Total =	907		299		120		92	

($ FY93 millions)

Figure 8. Budget Template #3 Future ASC RDT&E

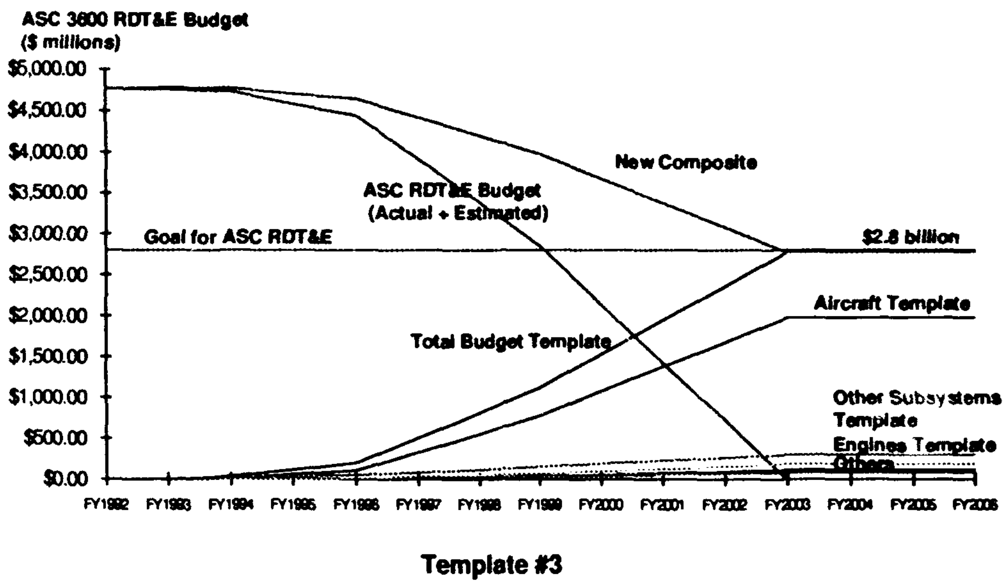

Figure 9. ASC RDT&E Total Budget Per Year ($ millions); Budget Template #3

3. GUIDANCE AND PRINCIPLES

To develop strategies for maintaining the design-build-operate teams in our defense industrial base, and the transfer of their technology ideas into warfighting systems, a working panel of government and industry research and development (R&D) and systems acquisition executives was formed (Working Panel: Technical Strategy for the Industrial Base) during the Chief Engineer's/Manufacturing Day with Industry held at the U.S. Air Force's Aeronautical Systems Center, Wright-Patterson AFB, Ohio, on 16-17 April 1992. Strategies described herein were developed during August 1992 through March 1993. The Working Panel members are listed in Figure 10.

WORKING PANEL: TECHNICAL STRATEGY FOR THE INDUSTRIAL BASE

Panel Chairmen:

Mr. John W. Steurer (Co-Chairman)	***Vice President, Integrated Product Definition***	***McDonnell-Douglas Aerospace-East***
Mr. John M. Griffin (Co-Chairman)	***Director, Development Planning***	***Aeronautical Systems Center, U.S. Air Force***

Members:

Dr. Ronald E. York	***Dir, Advanced Engineering Projects***	***Allison Gas Turbine***
Dr Robert W. DuBeau	***Deputy General Manager, Systems Develop. & Engrg Div***	***Westinghouse Electric Corp***
Mr. Robert E. Morris	***Manager, Technical Programs Development & Special Products Operations***	***General Electric Aircraft Engines***
Dr Leslie M. Lackman	***Vice-Pres & Pgm Mgr, Joint Primary Acft Training System***	***North American Acft, Rockwell International***
Dr. Thad H. Sandford	***Div Dir, Integrated Product Development***	***North American Acft, Rockwell International***
Mr. John K. Buckner	***Vice-Pres, Special Pgms***	***Lockheed Ft Worth Company***
Mr. Frank M. Rafchiek	***Chief Engineer***	***Boeing Co., Mil Airplanes Div***
Mr. Marvin L. Hurt	***Pgm Mgr, Adv Technology Business Acquisition***	***IBM Federal Systems Co***

Scribe & Publisher:

Mr. Bernard A. Schneider	***Development Planner***	***Aeronautical Systems Center, U.S. Air Force***

Figure 10. Working Panel Members

The Panel wanted to restructure the defense RDT&E business; not develop strategies facilitating a shrinkage of the current structure. It pursued ways to:

: shorten the time and decrease the cost to design and field new and improved systems,
: exercise company design-build-field teams more often,
: integrate manufacturing risk reduction early,
: emphasize continuous technology insertion to impact performance and affordability, and
: focus long-term development planning.

Three strategies can be employed to reduce the defense industrial base: a Shrinkage strategy, an Isolation strategy, or an Integration strategy.

A Shrinkage strategy proposes that the makeup and shape of the industrial base remain generally the same, but that it shrink to fewer government and corporate entities. The government would assume a laissez-faire policy toward industry, letting their shrinkage occur without intervention or guidance. It assumes that the defense industrial base will shrink to the correct size and shape for meeting DoD's future needs in a reduced budget environment. It assumes that the DoD will continue to fund lengthy, costly RDT&E programs, each tied to a production commitment, but fewer could be afforded. One can anticipate the decay and elimination of many of the company design-build-field teams, manufacturing floors, product support services, and test facilities due to a lack of profitable defense work. It could be depicted as a "shrinking circle"; however, some critical national defense capabilities may be lost, causing some "pie-shaped cuts" in the shrunken circle.

An Isolation strategy is a decision to do more of the acquisition and support functions within the organic military complex. It would lead toward an arsenal concept, or a large design bureau structure akin to the Soviet military infrastructure during the Cold War. Overemphasizing the preservation and use of the government's defense facilities and capabilities, at the expense of the private sector, would cause it to occur. Companies' experience, training and experience for design, engineering, manufacturing, systems integration, and product support would atrophy and disappear. Companies would discontinue development of military technologies, depriving the nation of worthwhile spinoff products.

An Integration strategy can be depicted with a "triangle" shape because it recognizes the need to change the shape of the industrial base in addition to its size. In addition to the commercial and defense product segments of the industrial base, there must greater integration of the two, forming a segment of dual-use products achieved through greater cooperation and sharing of resources between the government and private

industry. It requires the tearing down of barriers deterring the military's use of commercial products and practices. It requires greater integration of government and private skills and resources in the interest of keeping critical capabilities alive. This strategy is further described in Reference 4, reflecting the work of a group of ASC and logistic center leaders and managers during December 1992.

The government should be obligated to create an environment making it possible for companies to earn a reasonable return on investment on defense RDT&E. Contracts should provide profits to companies investing their money in defense-related technology and product development. In today's defense business, risks have increased, cash flows have diminished, and fewer new programs are being started. Production runs have been shortened or cut, and new business funds have dwindled. As a consequence, companies see little motivation to continue. They are moving quickly to downsize ("rightsize") to critical mass levels, and are consolidating their assets into profitable core product lines. Their stockholders and management are no longer tolerating unprofitable defense work.

Cost-type R&D contracts should be structured for at least 15% profit as an incentive for companies to invest their energies and resources in defense RDT&E. This is typical for commercial contracts, and would likely yield returns of 5% to 10% after subtracting taxes and other non-recoverable costs (such as interest expense). The DoD's technology development efforts are usually riskier than commercial endeavors; thus companies are less assured of an acceptable outcome. The government should be willing to incentivize companies to perform high-quality, innovative R&D work, and to reward them with extra profits when they are successful. Likewise, the government should share savings on contracts completed under target costs.

The U.S. defense industrial base to be preserved is summarized in Figure 10. It is characterized by the following assets:

1) companies capable of building, fielding and supporting major defense systems, subsystems and products,
2) suppliers providing the materials and components for the major U.S. defense companies.
3) government and company laboratories providing improved defense science and technology products and new warfighting capabilities,
4) government and industry test facilities needed to develop and demonstrate technologies, new products, and complete warfighting capabilities,
5) academia, think tanks, and small businesses,
6) DoD's technical, acquisition and management resources, and
7) DoD's logistics and maintenance centers that maintain the DoD's surge capability, the repair and support of out-of-production items, and the support of military items that are outside U.S. industry's main interests.

U.S. Defense Industrial Base Assets to be Preserved:

1) **companies**
2) **suppliers**
3) **laboratories**
4) **test facilities**
5) **academia, think tanks, and small businesses**
6) **DoD's technical, acquisition and management resources**
7) **DoD's logistics and maintenance centers**

Figure 11. Industrial Base Assets

Reasons to preserve the defense industrial base are as follows:

1) to support peacetime military forces,
2) to support military contingencies,
3) to produce war machinery to deter or defeat a global threat,
4) to deliver cost-effective, quality products to the DoD,
5) to continue during peacetime to develop, field and support technologically-superior weapons and platforms, either new or modified,
6) to integrate commercial technologies into military systems,
7) to spin off high-risk military technologies into useful commercial products,
8) to maintain healthy, robust and experienced build and field product teams capable of responding to urgent needs for mass-produced defense products in the of new threats, warfighting deficiencies, or defense stockpile drawdown,
9) guard against technological surprises on the battlefield, and
10) stimulate technological advances so important to the U.S. economy.

To respond as viable members of the industrial base, companies must have the ingredients listed in Figure 11. They must have:

1) a critical mass - a world-class team with the proper amount and balance of work and resources necessary to produce and support high-quality, affordable weapons systems,
2) an adequate and steady flow of profitable projects in order to maintain the vigor and experience level of their product design, manufacturing, and support teams, their manufacturing assets, and their suppliers (vendors) for materials, critical components, and specialized product lines, and
3) access to specialized test facilities during the development, testing and demonstration of their systems.

<u>Ingredients for Viable U.S. Defense Industrial Base Companies:</u>

1) **a *CRITICAL MASS* - a world class team competitive in areas such as:**
   - **..... systems engineering and systems integration,**
   - **..... technology leadership,**
   - **..... analysis capability,**
   - **..... design and development (including test),**
   - **..... manufacturing, and**
   - **..... fielding and support (spare parts, maintenance services, problem resolution).**
2) **an *ADEQUATE AND STEADY FLOW OF PROFITABLE PROJECTS* - to maintain the vigor and experience level of their teams .....**
3) **access to *SPECIALIZED TEST FACILITIES* - during development, testing and demonstrations of systems .....**

Figure 12. Viable U.S. Defense Companies

Products of the government-industry defense industrial base include:

1) new defense products and systems,
2) improvements to existing fielded products and systems, and
3) maintenance and logistics support.

Team capabilities (team being part of a company, part of a group of companies, or the government and industry group cooperating on a venture) needed to design, build and field products and systems include:

1) systems engineering and systems integration,
2) technology leadership,
3) analysis capability,
3) design and development (including test),
4) manufacturing and manufacturing process development, and
5) fielding and support (spare parts, maintenance services, problem resolution).

Components of a complex defense system which require industrial base resources and capabilities include:

1) total weapon system (primary equipment, training and support),
2) primary equipment (vehicle, ship, aircraft, missile, spacecraft),

3) system training,
4) system support,
5) major subsystems of the primary equipment (from subsystem suppliers), and
6) piece-parts and components (from part and component suppliers).

Where responsibilities should rest:

1) DoD clearly is responsible for defense system requirements (needs, functional capabilities, schedules, costs). The DoD must translate user (customer) needs into functional and performance requirements. It must exercise requirements "balancing" - to balance risk, capability, design, cost and schedule. The success of a RDT&E program depends upon balancing the functional and performance requirements with the design risk. The user states a need in terms of a mission deficiency. It is the product developer's responsibility to translate the user need into a set of functional requirements that become the foundation for industry's designs. User warfighting tasks are stated in the Mission Area Assessment which provides a disciplined strategies-to-task rationale. The user's Mission Needs Analysis systematically examines each task, and generates unfulfilled needs (described in Mission Need Statements) for those tasks where current and projected capabilities are not available. The DoD's product center development planners need to have active participation by industry in the development and evolution of the functional requirements in order to balance them with design risk, and to evaluate the impact of the requirements on the potential designs.

2) Industry is clearly responsible for system design. It must translate DoD's functional and performance requirements into system design requirements and then into design concepts.

4. CURRENT U.S. DEFENSE INDUSTRIAL BASE

The Office of Technology Assessment estimates that, as the defense budget is cut, as many as 250,000 workers per year will lose their jobs, with a projection to eliminate 2.5 million out of the 6 million defense-related positions in the U.S. market. In the U.S. aerospace industry as many as 400,000 to 500,000 jobs could be lost forever. AIA reports that 106,000 or 8% of the workers in the U.S. aerospace segment lost their jobs in 1991. This is the largest single drop in employment since the crisis of 1971. (Ref 13) The shrinkage causes ripple effects in local economies as lost jobs and wages impact local businesses and services.

By the year 2000, only four of the current seven manufacturers of U.S. military aircraft will likely remain. Analysts also predict that only two to four national leaders will emerge out of the current 16 leading defense electronics companies. (Ref 14) The number of aerospace/defense suppliers has dwindled to about 20,000 to 30,000 companies from 120,000 in the mid-1980's. More than 85% of the industry participants have already ceased business, or dropped their defense product lines. There are probably an additional 5,000 to 10,000 of the remaining suppliers that will exit the defense business during the next five years. (Ref 15)

People are the most important element of reconstitution efforts. In a shrinking industry, skilled people will be let go and they cannot easily be replaced. This will negate any new ramp-up in defense production. When highly skilled professionals leave the defense industry to go to other fields, their military technical knowledge quickly becomes dated, and such people are lost to the defense industry forever. (Ref 16) Significant shifts in personnel occur in companies converting from military products to commercial products. Forty-seven percent of employees at Raytheon's Equipment Division (radars and communications systems) are scientists and engineers. By contrast, 7% of Amana's employees are scientists and engineers. (Ref 16)

From Mr William A Anders, Chairman and CEO, General Dynamics Corporation: (Ref 17)

> *"One of the most important issues facing our defense industry and our government is reshaping this nation's "Cold War" defense industrial base - both public and private - into a "post-Cold War" defense industrial base configured to effectively and efficiently maintain and protect our future national security."*
>
> *"About a year ago, <u>diversification</u> was considered a "magic" solution. Defense companies would buy or create non-defense*

businesses. But the history of defense company diversification indicates a failure rate around 80%."

"This year, conversion is the "magic" solution. Transform defense production lines into commercial production lines. Also employ dual-use production lines. However, a year from now we will realize conversion will not work. Commercial markets and processes are radically different from those in defense, and are already fully served with strong competitors. Product and market development is expensive. Labor skills from defense are not usually required for commercial production."

"The solution in both the public and private sectors of the defense industrial base is a process called rationalization."

"Rationalization means mergers; it means selling and buying businesses; it means joint ventures; it means shuffling "nameplates" around; it means new, highly-focused defense companies; it means the realignment of public and private sector roles in the production and support of our nation's weapons systems."

RAND's 1992 report R-4199-AF, Maintaining Future Military Aircraft Design Capability notes: (Ref 12)

"In the 1950s, 49 new U.S. military fixed-wing aircraft were flown (and close to 20 in the 1960s); 4 new designs have flown in the 1990s, and expectations are for perhaps 1 or 2 more by the turn of the century."

"As one measure of design team experience, one can look at a ratio of new aircraft design starts compared to the number of design organizations. The ratio has declined steadily, from approximately 2.5 designs per team per decade during the 1950s, to the present level of about one new design per team every two decades."

"(From an engineer's experience viewpoint,) a 40-year engineer who began his career in the 1950s would have worked in an industry that developed and flew 84 new designs before he retired. An engineer who started in the 1960s will see only 40 new designs fly. Current industry managers are concerned that future senior technical staff will have designed only one aircraft in 20 years."

"The cost of sustaining a design capability, even through several years without prime aircraft development contracts, is relatively small (e.g., $100 million annually, plus facilities)."

"Minimum size of a viable military aircraft design organization is annual budget of about $100 million and about 1000 engineers and technical managers. Several types of facilities are also required, ranging from advanced composities labs to wind tunnels to radar ranges. This provides a core design team."

As stated by Mr Ed Ewing, Lockheed Fort Worth Company's Vice-President of Operations: (Ref 18)

"The industrial base is facilities, equipment, people, and know-how. It's purpose is to conceive and build products in a timely fashion for the defense of our country. It includes support and maintenance."

"Major defense contractors are facilitized for "100%" capacity, but typically operate at 60% during busy periods. Now defense industry capacity is 20% utilized. Procurement budgets are being cut from $160 billion to $50 billion. At this time, there are too many defense suppliers. These companies need to be combined; cutting out their vertical integration. Need to eliminate non-strategic, non-value-added processes. Need to get rid of surplus buildings, equipment and people. We should concentrate on preserving the industrial base, since engineering is 10% of the program; industrial base is 90%."

"When downsizing programs, business practices, and companies, we must decide what items are critically needed and what items are nice-to-have and can be eliminated. Defense contractors need to be profit-oriented to survive in the current defense market, and should resist unprofitable ventures simply for the defense of the U.S."

"There are too many overhead expenses on U.S. defense development and procurement programs, much of it due to government oversight, audit and documentation. One-third of labor cost on aircraft manufacturing is direct labor, the rest is overhead costs. 70-80% of defense product cost is unnecessary overhead costs. If this overhead can be eliminated, more dollars will be available to preserve the industrial base. We should not solve our problems by cutting back on the number of defense products while keeping the same business practices, we must change the current business practices to save expenses and time on programs. Government needs to concentrate on eliminating agencies and organizations performing inspections, audits, and

other overhead/administrative functions that are non-essential cost and schedule factors on defense programs."

Professor David Blair of the Air War College writes: (Ref 19)

"The key to reconstitution is capital - physical, human, and organizational (physical capital, human skills, and manufacturing and research organizations needed to produce new weapons within a relevant time frame)." Any attempt to reconstitute U.S. military force structure will depend upon the capital stock that is available at the time the decision is made to begin the reconstitution. The worrisome aspect of the current defense downsizing is that decisions are being made that will have the effect of scrapping billions of dollars worth of capital and there is no systematic procedure to determining which capital will be most essential in a reconstitution effort and which can be safely discarded."

"People can do all the studies and issue all the policy guidance they want, but if these steps do not affect the process through which the DoD decides which contracts will be let, they have little or no effect on the defense industrial base."

"A minimum first step (concerning the idea of designing military equipment so that it uses a lot fewer dedicated military components that are not available in the civilian sector) would be for the DoD to develop procedures to classify equipment into three categories: (a) the civilian product can be used directly, (b) the product must be specialized but civilian production lines can be used, and (c) the product will require specialized production lines. It would be very useful to be able to prioritize defense capital stock (both human and physical) according to its effect on a reconstitution effort. The DoD should be able to sort out capabilities into three categories: (a) purchasable on the civilian market, (2) purchasable with less than two years lead time, and (3) not purchasable without a long-term capital commitment."

In a recent issue of FOCUS by the National Center for Manufacturing Sciences:

"For half a century, the United States has established its priorities and policies according to international boundaries and political ideologies. While the nation was actively engaged in a national security battle, it devoted most of its technological resource to defense endeavors." .....

"The end of the Cold War has brought new economic realities to the forefront of the American agenda. The country's status as a geopolitical superpower is undisputed, but it status as an economic superpower has slowly decline in the past 20 years." .....

"Manufacturing is of strategic importance to America's global competitiveness," according to Laura D'Andrea Tyson, head of the Council of Economic Advisors. "Recognition (of manufacturing's importance) goes beyond the simplistic notion of picking winners and losers." Tyson stresses. "Business leaders know that without a viable manufacturing sector, the U.S. economy will neither provide a rising standard of living to workers nor allow producers to remain competitive in world markets."" .....

"Remarkably, America has been lax in allocating public and private resources to upgrade its manufacturing sector. Many industries - once considered U.S. institutions - have been decimated by their inability to compete against foreign rivals. Insufficient capital investsment, coupled with unfavorable domestic trade and monetary policies, has hobbled U.S. industrial leaders." .....

"An American policy should encompass key elements such as: collaborative development and deployment of advanced technology; improved worker training; and formation of domestic initiatives which promote exports, counter foreign subsidies, open closed markets and build strategic industries that generate "significant knowledge and technological spillovers for the entire economy," she says." (Ref 20)

"......for American manufacturers to regain their competitive edge, it will take a dramatic shift in the way they're doing business. Government and academia must be partners in this change. It's not enough for U.S. industry to compete at this point in history; it must surpass the best efforts of its toughest opponents." (Ref 21)

"Technological Leadership Factors: (Ref 22)
- *: Products with high R&D content.*
- *: State-of-the-art manufacturing processes.*
- *: Superior understanding of technology.*
- *: Unique manufacturing processes.*
- *: Innovative products."*

5. TECHNOLOGY'S FUTURE

The Defense Department's Office of the Deputy Secretary of Defense for Research and Engineering has a July 1992 strategy for science and technology that states "The core of this strategy is to 1) provide for the early, intensive, and continued involvement of warfighters, 2) fuel and exploit the information technology explosion, and 3) conduct extensive and realistic technology demonstrations." Major advanced technology demonstrations (ATDs) will be conducted in each of the seven DoD science and technology thrust areas - 1) global surveillance and communications, 2) precision strike, 3) air superiority and defense, 4) sea control and undersea superiority, 5) advanced land combat, 6) synthetic environments, and 7) technology for affordability. Two types of ATDs are planned. One will be focused on new systems and subsystems concepts. The other will be focused on enabling technologies. The first may represent prototypes, and the second may represent brassboards. With fewer new system starts, investment in technology has its greatest payoff in pushing development to the very edge of making a system decision. The intent will be to carry technology further along in the technology base, rather than prove it after a decision to build a weapon system. This will require increased resources in the technology base. The DoD S&T strategy is heavily dependent upon being adequately funded.

Laboratory exploratory development will be built around eleven (11) key technology areas as listed in Figure 13. These are: 1) computers, 2) software, 3) sensors, 4) communications networking, 5) electronic devices, 6) environmental effects, 7) materials and processes, 8) energy storage, 9) propulsion and energy conversion, 10) design automation, and 11) human-system interfaces.

Eleven (11) Key Technology Areas:

Computers	**Software**
Sensors	**Communications Networking**
Electronic Devices	**Environmental Effects**
Materials and Processes	**Energy Storage**
Design Automation	**Propulsion and Energy Conversion**
Human-System Interfaces	

Figure 13. Key Technology Areas

Linkage between laboratory science and technology efforts and the RDT&E of weapon systems is shown in Figure 14.

During his February 1, 1993 speech to the Armed Forces, Secretary of Defense Les Aspin remarked: (Ref 2)

> *"I think the challenges we will face together fall basically into two categories. One category concerns the top priority things the Defense Department has to do at home. Essentially, that means maintaining the superb quality of our forces and the high technology advantage we have in our systems as we face the inevitable drawdown of these forces."*
>
> *"The second category of challenges concerns dealing with the dangers we face in this fast changing, post-Cold War, post-Soviet world."*
>
> *"On high technology, during the Cold War, we faced an opponent who relentlessly fielded new systems in larger and larger numbers. We responded by producing our own new generations of systems with emphasis on technological superiority. We reasoned that if we could not out-build them, we could compensate, perhaps more than compensate, by maintaining a technological advantage. With the end of the Cold War, the need to continuously field new generations of systems is not out of the question, but high technology has only proved to be more valuable, as we saw in the war with Iraq. High technology, precision weapons, and other systems reduced U.S. casualties, brought a more rapid end to the war, and reduced civilian caualties bhrough such developments as reduced collateral damage, and that is what put it all together for us. The high technology systems were at the heart of that successful enterprise."*
>
> *"The difficulty that looms before us today is how to maintain this technological edge into the future decades, when we have to have this technological edge, and how do we maintain the industrial base to produce these systems without the high production levels of the old Cold War budgets? Together, we need to answer that question."*

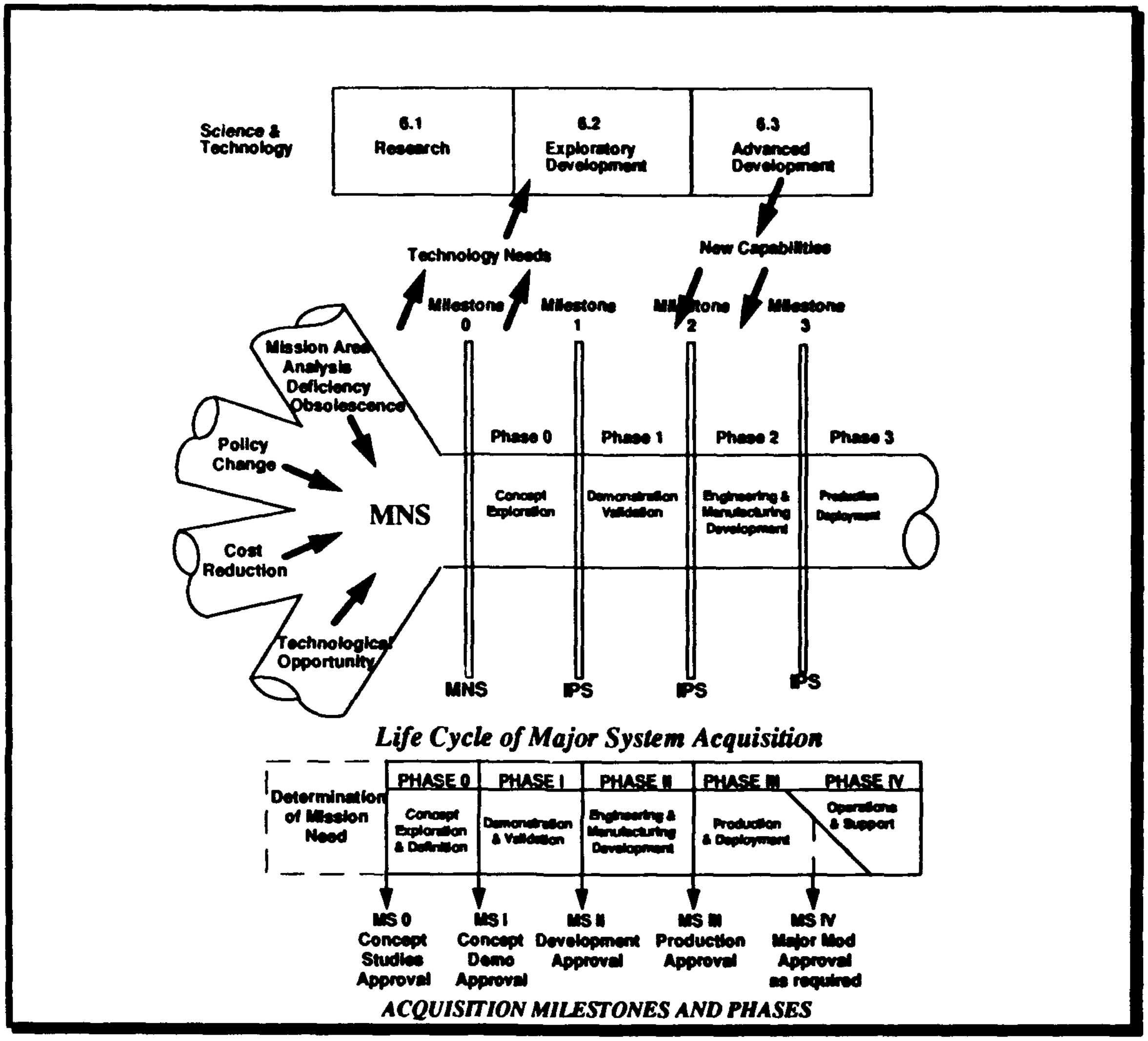

Figure 14. Linkage Between S&T and System RDT&E

6. CRITICAL CAPABILITIES

Critical national needs in the post-Cold War era, to be satisfied with far fewer dollars, include: 1) effective national security, 2) a more efficient, innovative and responsive defense industrial base, and 3) greater international competitiveness with the results of DoD's R&D and procurement spending. (Ref 23)

The Working Panel defined six (6) critical capabilities to maintain and improve in our U.S. defense industrial base. These are summarized in Figure 15.

Six Critical Capabilities to Maintain and Improve in the U.S. Defense Industrial Base:

#1: Strong company S&T teams.

#2: Integrated product design and development teams in companies.

#3: High-value test and demonstration facilities.

#4: Innovative technology development within the supplier base.

#5: Innovative, cost-conscious program and technical management.

#6: Improved contracting processes, eliminating non-value-added activities.

Figure 15. Six Critical Capabilities

The six critical capabilities are further explained as follows:

#1: Strong company science and technology (S&T) teams and programs. Innovative technology development teams within companies.

#2: Full-capability, integrated product design and development teams within and among companies. Engineering and design teams that can quickly and efficiently design, build, and demonstrate new technologies and products, that can build and field complete warfighting systems, and that can move smoothly and swiftly from concept and prototype into full engineering and manufacturing development and production. Multidisciplinary teams that can: 1) improve existing systems, 2) design and

integrate and demonstrate new technologies, and 4) build, field and support small fleets of specialized vehicles for future warfighting needs in regionalized conflicts.

#3: High-value facilities that are the central core of government and industrial test and demonstration capabilities. Government and industry facilities that can be shared and used to develop, test, and demonstrate new technologies, system concepts, and warfighting capabilities. Our nation's centers of excellence for test capabilities.

#4: Innovative technology development within the U.S. infrastructure of suppliers and vendors. This nation's defense material suppliers and small business engineers, consultants, and analysts. Their abilities to invent new technologies and warfighting systems.

#5: Improved program and financial management. Multicompany and multidisciplinary teams led by managers, engineers and financial experts trained in leading innovative, streamlined cost-conscious projects. Increased use of concurrent engineering, integrated product development and rapid prototyping. Close working relationship between government and company teams to facilitate project efforts. Minimized overhead tasks.

#6: Improved contracting and acquisition processes. Processes fostering two-year CE&D studies, three-year Dem-Vals, and four-year EMDs in an effort to shorten RDT&E and reduce costs. Elimination or reduction of non-essential overhead cost items. Early selection of competent sources for RDT&E work, avoiding extra costs for protracted competition.

7. PANEL'S "DESIGN-BUILD-OPERATE" STRATEGY

The Panel's "Design-Build-Operate" strategy is intended to provide company teams with a steady flow of profitable design-develop-build-field-support projects. At the same time, it enables the DoD to field and demonstrate new and improved equipment to satisfy the warfighter's long-term needs (20 to 25 years).

The strategy has nine (9) elements and is described in the PANEL'S RESULTS section of this report (summarized in Figure 3).

In the Panel's approach to Dem-Val projects, the warfighting command is much more involved. The user would assign a representative to each Dem-Val, with that person responsible to provide a user's need perspective. That person would also participate in the balancing of requirements and the system design. He/she would help integrate the new product into the user's daily operational concepts, and evaluate its potential effectiveness. After Dem-Val testing, the hardware and software would be given to the user for long-term evaluation and use. It would be supported by the company team.

In the Panel's concept for EMDs, these programs would build and field a small quantity of pre-production systems or vehicles. Although two vehicles may be sufficient to address and resolve issues as they arise during design and construction, a half dozen or more vehicles (e.g., aircraft) provides the user with a small fleet of vehicles for long-term evaluation and use. In most cases, the contractor would provide long-term field support and maintenance of these vehicles. This experience enhances the contractor's ability to produce and support the vehicle in large quantities when the need arises.

Other strategies supported by the Working Panel include the following:

: encourage movement toward more integration of military and commercial products and company product lines,
: identify and budget for preserving military-critical elements of the industrial base,
: pursue advanced technology demonstrations and laboratory pilot product programs and system demonstrations,
: utilize consortiums of government and industry organizations, companies, and teams, and
: encourage companies toward more vertically-structured teams.

The use of commercial or dual-use products and practices in military systems and field support should be more widespread. The government should stimulate commercial and defense companies and their suppliers to apply their technologies and products to both marketplaces.

Companies should be encouraged to diversify their technologies and products by fostering more multi-use, multi-customer programs. There should be incentives for government and industry to cooperate (including shared funding) on multi-use, multi-customer technologies and products.

The Panel suggests the formation of consortia to improve and disseminate high-technology design tools (models, simulations, design software, etc.) used to develop U.S. defense systems. Including tools and skills that may be lost or wasted during industry's downsizing, in areas such as flight control synthesis, structural design modeling and aerodynamic modeling. Consortia could maintain and improve the tools, maintain lessons learned during their prior use, and provide consulting services. By focusing efforts and RDT&E dollars through the consortia, the U.S. could coordinate efforts to develop new tools for maintaining world aerospace design leadership.

Pooled government, industry and academia resources in the consortia could be located in the government's laboratories. Perhaps 30 to 50 scientists and engineers from defense and industry could be employed.

The Panel advocates using an integrated network information database, a "public library", to house and maintain knowledge gained from years of aerospace systems engineering experience. The library would contain design and development data in specialized technical areas such as aircraft landing gear design, aircraft electrical wiring and cabling design, etc., that tend to become forgotten or lost engineering arts. It would contain the Air Force's Mil-Prime specification data and lessons-learned information.

To provide for strong industry participation in the Services' overhaul, maintenance and modification of fielded defense hardware and software, the Panel suggests that certain criteria be considered when selecting the source (Service's organic capability or a contractor) for this work. A decision concerning the placement of a work program should be based on an economic and industrial base trade study that considers: 1) content of systems engineering work and systems integration work beneficial to company design-build-field teams, 2) availability of competition between companies, 3) manufacturing needed to produce modification packages which will offer opportunities to exercise company factory floors, 4) company vertical teaming arrangements which may be used to solidify the core capabilities of the industrial base, and 5) opportunities for combined government-industry team arrangements.

8. STRATEGIES TO MAINTAIN THE SIX (6) CRITICAL CAPABILITIES

Capability #1: *Strong company S&T teams and programs:*

We must maintain innovative technology development and demonstration teams within companies. This work must be profitable and rewarding. Their independent and government-funded programs must be well-supported by company leadership. They need comprehensive guidance from the DoD on future warfighting needs and technology interest areas.

Strategy #1.A: Formulate long-term development plans (20 to 25 years) to describe military's needs and to map the Service's RDT&E and production plans to meet those needs.

Planners from the warfighting commands and Service's product centers and support centers need to formulate 20 to 25-year development plans. The development plans, formulated for broad mission areas (e.g., air superiority, air-to-surface, training, mobility, special operations forces) describe the results of strategy-to-task (mission area analysis) and task-to-need (mission need analysis) efforts by the warfighting commands, supported by product center contracts and in-house analysis efforts. They also describe a set of potential solutions, prioritized according to their relative operational payoff, technology maturity, and developmental risk. Efforts to pursue these solutions are "roadmapped" into a 20 to 25-year course of action for product center RDT&E and system acquisitions.

A wide assortment of pre-Milestone 0 mission need study contracts would be awarded each year by each defense product center in order to establish and maintain these plans. Contracted tasks performed by industry to support mission need studies include: modeling and simulation, operational effectiveness requirements, functional capability requirements, weapon requirements, potential programmatic risks, development and acquisition strategies, application of new and modified commercial and military items and technologies, potential concept solutions, and potential RDT&E costs, schedules, and budgets.

Aeronautical Systems Center's Directorate of Development Planning (ASC/XR) manages five (5) Technical Planning Integrated Product Teams (TPIPTs) responsible for formulating the development plans for the broad mission areas of counterair, air-to-surface, mobility, special operations, aircrew training, electronic combat, and base operability/defense. The teams consist of warfighting command planners, ASC

planners, designers, analysts, engineers, and laboratory technologists. The Directorate provides comprehensive analytical and engineering support. The plans describes ASC's approach to RDT&E and production for aircraft, missiles, munitions, engines, and other subsystems. An integral part of the plans is technology development guidance published in the Technology Investment Recommendation Report to the laboratories (for ASC, it is directed primarily to Wright Laboratory) used to guide the lab's technology area plans (TAPs), and advanced technology demonstration programs (ATDs).

Strategy #1.B: Insure that industry understands the Service's long-term warfighting needs (described in the development plans).

The Service's product centers must assure that all sectors of the defense industrial base have a good understanding of future needs. Industry can then respond by aligning their long-range business plans for DoD-related S&T/R&D within profitable business structures. Industry must be involved in studying DoD's needs in order to truly understand those needs and to understand how to provide innovative solutions.

Strategy #1.C: Assure companies an opportunity to earn a satisfactory return (profit) on all types of S&T and RDT&E work.

Cost-type R&D contracts should be structured for at least 15% profit as an incentive for companies to invest their energies and resources in defense RDT&E. This is typical for commercial contracts, and would likely yield returns of 5% to 10% after subtracting taxes and other non-recoverable costs (such as interest expense). The DoD's technology development efforts are usually riskier than commercial endeavors; thus companies are less assured of an acceptable outcome. The government should be willing to incentivize companies to perform high-quality, innovative R&D work, and to reward them with extra profits when they are successful. Likewise, the government should share savings on contracts completed under target costs.

Companies should not invest their own money for studies and prototypes leading to potential DoD contracts for products or systems, unless self-motivated. They should not make unreimbursed up-front capital investments in tooling, materials, facilities and personnel associated with major system development programs. The government should pay all costs to companies on R&D contracts, including their fees, when the contract is cancelled or significant changes occur.

The government should employ the award fee approach to pay a basic profit on contracts, and should use an incentive award to pay for good cost, schedule and/or technical performance.

Companies should fully recover IRAD costs directly responding to and supporting the product center's development plans and technology needs.

To preserve and stimulate U.S. leadership in warfighting science, technology and RDT&E, the government should provide tax incentives to stimulate company capital investments in new capabilities.

To guard against market unknowns such as interest rates and inflation, the profit rates on defense RDT&E contracts should be adjustable using a popular market index such as the Treasury Bill Rate.

Capability #2: ***Full-capability, integrated product design and development teams within and among companies:***

We need to preserve and maintain full-capability, full-service engineering and design teams that can quickly and efficiently design, build, and demonstrate new technologies and products. Teams that have the capability to build and field complete warfighting systems. Companies must be able to move smoothly and swiftly from concept and prototype into full engineering and manufacturing development and production. Multidisciplinary teams must be able to: 1) improve existing systems, 2) design and build new systems and products, 3) build and operate experimentation testbed vehicles to integrate and demonstrate new technologies, and 4) build, field and support small fleets of specialized vehicles for future warfighting needs in regionalized conflicts.

Strategy #2.A: Provide a continuous stream of opportunities for profitable RDT&E projects to the industrial base companies supporting the Service's product centers.

Competitively award frequent projects to companies. The contracts are for mission needs studies, CE&D studies, Dem-Val projects and EMD programs. These serve to build the training and experience of companies' design-build-field teams.

These projects demonstrate new technologies, concepts and warfighting techniques for the warfighters, and give them an opportunity to develop new tactics and to assess their utility.

Strategy #2.B: Build and field small fleets of military systems (e.g., aircraft, weapons or other warfighting materiel).

Build and field a few aircraft, weapons or warfighting systems to have a small fleet of mission-specific vehicles or weapons, or to field improved or specialized versions of an existing system. Try out new operational concepts and tactics. Or work on improvements to the maintenance and support of current-day aircraft and weapons and the problems they present to the operational warfighting commands. Let the company provide long-term test, operational and maintenance support. This has several advantages:

1) having specialized or technologically-superior aircraft, weapons or vehicles on hand for use in a military contingency,

2) exercising the company's full range of R&D, production and support capabilities, including design, concurrent engineering/IPD, fabrication,

manufacturing, assembly, integration, checkout, maintenance, logistics supply, fault reporting and investigation, corrective action, test equipment and tech manuals, and maintenance reporting. They exercise producibility engineering, affordability engineering, operational test and evaluation, manufacturing planning, and logistics support planning,

3) permitting the military customer to develop tactics for the effective use of new and improved systems,

4) making the military customer operate and support the system with personnel, mobility, transportation, support equipment, tech manuals, training, supplies, system management, and software maintenance management,

5) demonstrating and making available the improved warfighting systems and capabilities generated by science and technology programs,

6) exercising the supplier base for components and specialized products needed for military systems (including stimulating the suppliers to pursue technology development), and

7) assuring the DoD's product centers and support centers of viable competitive industry sources for new and modified systems, products and services.

Strategy #2.C: Encourage the use of commercial or dual-use products and practices in military systems and field support.

Stimulate more commercial or dual-use products (both commercial and military use) to satisfy military needs for warfighting systems and their field support. Encourage commercial and defense companies and their suppliers to apply their technologies and products to both marketplaces. Change government contracting rules and technical specifications to accomodate more applications of products built to commercial standards. Avoid costly military development of items very similar to commercial products. Apply commercial practices to the maintenance and support of these items in the military environment.

Many air mobility and training missions are currently accomplished by modified FAA certified aircraft. These include over 29 different types and almost 1000 aircraft (see Figure 16). These procurements required exceptions to the traditional aircraft acquisition approach by DoD. Aeronautical Systems Center (ASC) already uses streamlined test and evaluation procedures on a limited basis. These include integrated U.S. Air Force qualification, operational, and airworthiness certification testing by the FAA. ASC has also made adjustments in contracting practices in the use of commercial

versus military specifications for qualification criteria. The Commercial Aircraft Acquisition Critical Process Team Report (Ref 24) identifies and recommends measures to improve the efficiency and, as a result, reduce the costs of DoD aircraft acquisitions by integrating the commercial aircraft acquisition process.

The C-20H Program is a current acquisition program using commercial products and practices. This Special Airlift Mission aircraft started as a off-the-shelf commercial production Gulfstream IV. It then went into the Gulfstream Completion Center to be outfitted with a customized interior, as is done with every aircraft that comes off their production line. The aircraft and interior were completed to commercial standards, certified by the FAA, and paid for according to Gulfstream's normal commercial payment plan. The aircraft was then flown to E-Systems for installation and FAA certification of the Mission Communications System. This subsystem consists of both commercial and military equipment that must satisfy the functional requirements levied in the contractual specifications and the FAA certification requirements. (Ref 25)

The Radio Frequency Mobile Electronics Test Set (RFMETS) Program is developing a Software Development System (SDS) based entirely on commercial hardware and software. The system uses 486D x 266 computers, Hewlett Packard printers and Windows NT software. (Ref 25)

The General Electric F108 engine for the Air Force's KC-135R is similar to the CFM56-3 engine used on the Boeing 737. The Air Force purchased this engine commercially, using the same manufacuring, quality and warranty systems. It took advantage of the lower costs of large-scale production of the CFM56, and the purchase expanded GE's production base. GE could offer a more attractive price in the international commercial jet engine market. Military engine production and commercial engine production often use similar manufacturing processes and facilities, including machining, laser drilling, nondestructive inspection, etc. When manufacturing process technology is infused early in a military engine program, it will rapidly find its way into the commercial counterpart engine. This enhances U.S. competitiveness and fosters dual-use opportunities.

Another example is the F117-PW-100 engine used in the Air Force's C-17 airlifter which is similar to the Pratt and Whitney 2000-series engine used in the Boeing 757 commercial aircraft.

U. S. Air Force FAA-Certified Aircraft:

Military Designation	Commercial Designation	Quantity Procured
T-39	Rockwell Sabreliner	14
T-41	Cessna 172	204
T-43	Boeing 737-100	18
VC-137B/C	Boeing 707-120/707-320	7
C-140	Lockheed Jetstar	16
C/VC-9	Douglas DC-9	24
E-3	Boeing 707-320	34
E-4	Boeing 747-100	4
E-8A/C	Boeing 707-320	22
KC-10	Douglas DC-10-30-CF	60
C-12F	Beech Super King Air	40
EC-18	Boeing 707-320	7
C-20A/B/C	Gulfstream III	13
C-20H	Gulfstream IV	1
C-21A/B	Lear 35	84
C-22B	Boeing 727-100	4
C-23A	Shorts 330	36
VC-25A	Boeing 747-200	2
C-26A	Fairchild Metro III	14
C-26B	Fairchild Metro 23 (Commuter)	53
C-29A	British Aerospace 125-800	6
T-1A	Beechjet 400	180
FMS	(foreign military sales) Cessna 206, Cessna 210, Cessna (Citation), Cessna 150 Aerobat, Bell 212 Helicopter	25
T-3A	Slingsby Firefly	113
	Total	981
		(Ref 25)

Figure 16. USAF FAA-Certified Aircraft

Strategy #2.D: Provide funding and incentives for manufacturing technologies:

The DoD should continue to fund new technologies in manufacturing practices, processes, machinery, and facilities. To support the well-being and competitiveness of U.S. industries, it should be willing to share the costs. New processes and products should be integrated into defense work in order to achieve savings during production, operations, and support.

In the jet engine industry, it is estimated that up to 70% of performance gains result from advances in materials and manufacturing technology. (Ref 26) The ability to affordably machine exotic materials into shapes and configurations demanded by future military and commercial aircraft and missile jet engines is the foremost challenge for the propulsion industry. In the mid-1980s, the Air Force Wright Laboratory Manufacturing Technology ("ManTech") Directorate recognized this need and established the Advanced Propulsion Materials Manufacuring Technology Program. This visionary program awarded large, far-reaching contracts to the two companies competing for the prototype Advanced Tactical Fighter (i.e., YF-22 and YF-23) engines, namely - General Electric with the new high-performance F120 engine, and Pratt and Whitney with the new high-performance F119 engine. The contracts funded extensive jet engine manufacturing technology development in parallel with the aircraft's demonstration-validation program. This enabled new jet engine manufacturing processes to be available for the start of the Air Force's F-22 air superiority fighter engine EMD program. General Electric and Pratt & Whitney lead numerous subcontractors who performed much of the technology development. Processes for advanced-design integrally-bladed rotors, large high-temperature structural composites, advanced materials and product-process simulation were brought to fruition during this program. These efforts in the laboratory's program substantially reduced the development risk for this new high-performance military engine, and will reduce its production costs. These technologies and processes will rapidly find their way into other military and commercial engines.

Strategy #2.E: Use schedule-saving system development practices employed on commercial programs.

Adopt streamlined practices and schedules used by companies for commercial product deveiopment. Examine how aerospace companies develop and certify commercial aircraft. Use lean, streamlined project teams and concurrent engineering practices.

Reduce companies' overhead costs and burdens for government's project management, contractor surveillance, financial reporting, and contract administration tasks. Realize cost and schedule savings by eliminating non-essential administrative and overhead management activities.

In the X-31 aircraft project, some practices that resulted in a 50% savings in engineering hours over the prior X-29 project were: 1) continuous improvement of a team-based design, 2) multidisciplinary design and development teaming, 3) use of CAD/CAM, and 4) 50% of engineering accomplished without paper products.

Douglas Aircraft Company employs several schedule-saving, cost-saving techniques to develop and produce commercial aircraft. Figure 17 compares their development schedules for military and commercial aircraft.

Chrysler Corporation's *Viper* automobile development, using concurrent engineering principles, illustrates the ability of a well-focused team to develop a high-performance production automobile within 5% of normal development cost (under $100 million) and in record time (two years for an operational preproduction prototype; three years for initial production). This auto employs a number of technological breakthroughs, including non-fade brakes, RTM plastic body panels, press-bent windshield construction, and a totally new V-10 488 cubic-inch engine. Using a skunkworks approach, the developers of the *Viper* wanted to get back to the basics of keeping it simple. They worked as a team with multidisciplines integrated together, using computers to do scheduling and CAD/CAM. 50% of the tooling from CAD was released by engineering without paper drawings. They used a no-walls concept to enhance communication and simultaneous engineering. The team consisted of 50-75 people working under a constrained budget toward building a car with clear simple capability objectives. Their mission statement was ... "To build a simple, straightforward, high performance driver's car on time, on cost target and at a defect-free level."

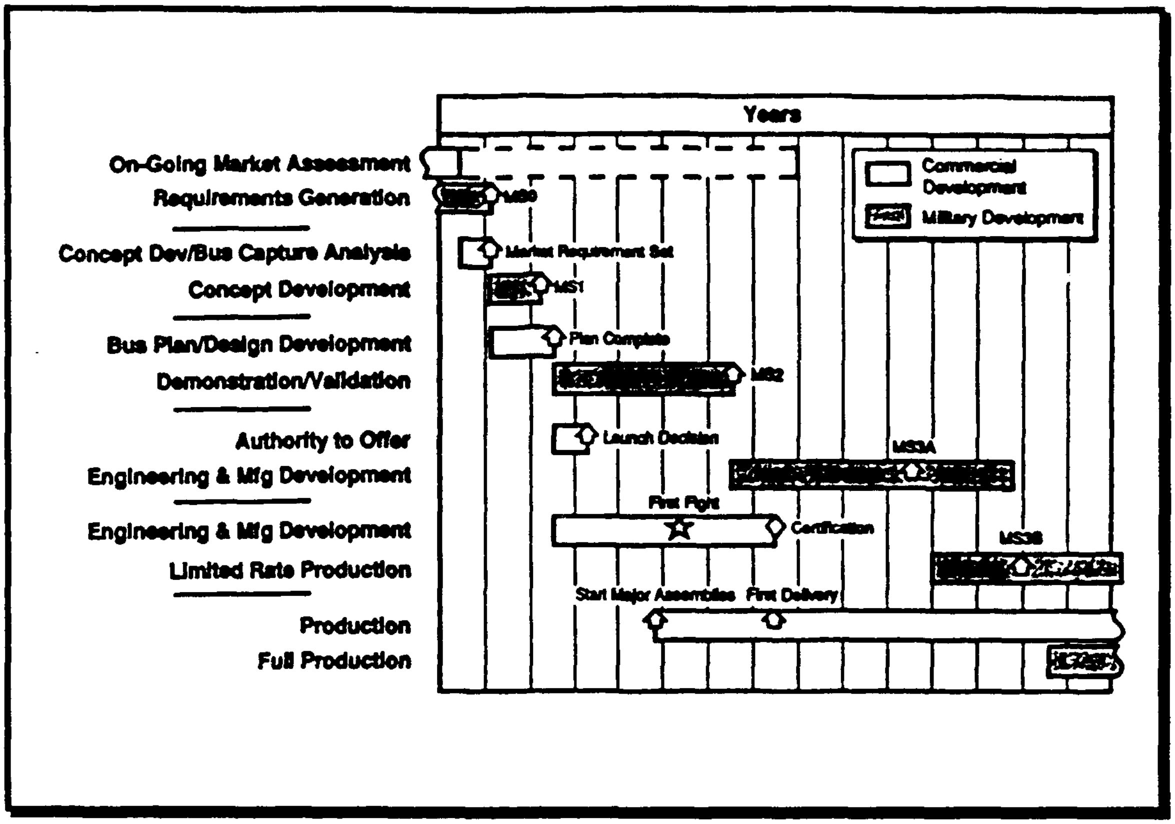

Figure 17. Commercial Aircraft vs Military Aircraft Development

Capability #3: ***<u>High-value facilities ...... especially test facilities and testbed aircraft platforms ...... that are the central core of government and industrial test and demonstration capabilities.</u>***

Government and industry facilities must be shared and used to develop, test, and demonstrate new technologies, system concepts, and warfighting capabilities. They provide our nation's centers of excellence for test capabilities.

Strategy #3.A: Encourage government, industry and academia to cooperate and share essential military and commercial test and demonstration resources.

Form consortia of government, industry and university organizations to share funding for operating and maintaining U.S. test resources and facilities. Identify and maintain critical facilities and capabilites; close down unnecessary or duplicative facilities. Institutionalize and maintain the best facilities as national Centers of Excellence.

During 1991-1992, DoD and industry organized a project to write a U.S. <u>Hypersonic Test Investment Plan ("HTIP")</u> for the purpose of defining and estimating the costs of improved and new U.S. hypersonic test facilities to support U.S. development of hypersonic vehicles over the next 30-50 years. Current facilities are often 50 years old, and do not provide needed capability. An executive council of senior executives from government and industry test and system acquisition agencies was formed and chaired by the Air Force's acquisition executive. Members came from NASA headquarters and their research centers, Army, Navy, Air Force, aerospace industries, and academia. The executive council chartered a working group of organizational managers from these agencies which was co-chaired by Air Force Wright Laboratory and Headquarters, NASA. The new HTIP plan (Ref 27), soon to be released, provides a comprehensive and authoritative blueprint for building and maintaining world-class U.S. hypersonic test facilities. With these facilities, the U.S. will be assured of having the test facilites and capabilities to efficiently and accurately build future hypersonic systems.

Strategy #3.B: Share high-value testbed platforms (e.g., testbed aircraft) to host and demonstrate advanced technology products.

Have an assortment of high-value, shared testbed aircraft (X-type aircraft) in the DoD and in companies to provide for technology and product development and demonstration.

Use a few existing aircraft in the operational fleets as repositories for advanced technology ideas and products. Modify a handful to operationally evaluate a new technology capability and to have it ready to respond to a crisis situation. Not just tactical aircraft. Also must have larger platforms to do avionics investigations, etc. where you might not want to "form-factor" the test specimen into a fighter-sized platform. Use these small fleets of special-mission aircraft to handle warfighting problems in small-scale military operations and conflicts.

The Air Force's C-135C "Speckled Trout" airplane has long been used to evaluate new avionics subsystems. This function is now being performed by ASC's C-141 "RAMTIP" aircraft. (Ref 28)

NASA Langley Research Center's 515 airplane (a Boeing 737) has been used for a number of years in a similar role.

Westinghouse and Hughes possess testbed aircraft for radar evaluations. Boeing uses a 757 airplane with an experimental certificate for both aerodynamics testing and avionics testing. For high performance and technology flight tests, Wright Laboratory and others use experimental versions of the F-16 and F-15.

Strategy #3.C: Integrate weapons, aircraft and theater support assets to demonstrate complete warfighting capability and effectiveness.

Strive for complete warfighting capability demonstrations to the military customer, employing aircraft or vehicle platforms, integrated weapons, support assets, threats, command and control nets, theater support and logistics, and other elements.

The ARTEMIS Precision Strike program will develop, integrate and demonstrate communications, command and control, and identification (C3I), mission planning, strike aircraft, and weapon technologies to support affordable, adverse weather precision strike capabilities with emphasis on time-critical fixed and mobile targets.

Strategy #3.D: Streamline flight testing methods for RDT&E.

Use techniques to streamline the flight testing process, including: 1) FAA experimental aircraft flightworthiness certificate, 2) reduced performance specifications for the vehicle, thereby reducing testing needs, 3) reduced scope of customer testing requirements, thereby cutting customer test programs, and 4) accelerated envelope expansion.

Commercially-owned testbed aircraft usually have only an experimental flightworthiness certificate. Approaches 2) and 3) above were used during the YC-14 and YC-15 programs. That is, airplane "g" capability was relaxed from production requirments and full-scale static and fatigue testing was not required. Approach 4) above was applied during the Condor program.

Some guidelines for streamlining the flight testing of prototype aircraft are provided by Mr John Steurer, Vice President, Integrated Product Definition, McDonnell Douglas Aircraft-East as follows:

> a. Ensure close cooperation and working relationship between the customer and contractor flight test team, with support by military ranges and chase aircraft. Have an expeditious aircraft clearance process in place, or obtain a blanket clearance for the entire

program, while giving autority and accountability to the contractor to accomplish the test program. Have only one military customer in the daily flight decision-making process.

b. Negotiate major reduction of specifications against which performance must be demonstrated.

c. Conduct mini-OPEVAL at the completion of Dem-Val by military pilots to assure that the essential performance capabilities of the aircraft can be achieved, thereby meeting the exit criteria for Dem-Val and the entrance criteria for EMD.

d. Maximize the use of simulation to predict first flight and subsequent envelope expansion flight flying qualities. Use simulation to explore aircraft failure modes/analysis/recovery techniques.

e. Test planning and operations need to concentrate on developing the high-risk technology areas; i.e., envelope expansion, flying qualities, propulsion, performance, and new technology areas. If avionic high-risk areas are involved, use of testbeds should be explored. Keep aircraft configuration changes to an absolute minimum; changes should only be allowed to resolve a safety-of-flight problem.

f. Inflight refueling and hot refueling, which may not need demonstrating, can increase test efficiency. If given the choice, have the capability.

g. Don't take risks with instrumentation and data processing systems, particularly during short programs. Use proven instrumentation systems and data processing hardware and software.

h. One or two prototype Dem-Val aircraft will be tasked with testing critical technology areas; normally accomplished by 7-9 aircraft during EMD. The burden of maintenance, instrumentation, data processing and analysis on these one or two aircraft is great. Ensure support is available for high-intensity tasks.

i. Record flight test data for key technologies early. Process the data and look at it. Do not permit surprises concerning critical instrumentation to occur late in the game.

j. If "discriminator" demonstrations are contemplated for the end of the program, include the instrumentation and buildup points necessary to achieve them in your planning.

k. Fast data turnaround and timely analysis must accompany data-gathering when using a heavily instrumented aircraft.

Late data, or data that's not looked at till the last minute isn't worth the investment in instrumentation. Make sure that the commitments to instrumentation, data processing, and analysis are in balance.

l. Onboard data processing and automated data quality checks can help speed decision-making and improve data quality. Lacking onboard processing, the test team needs to plan for and execute real-time test point analysis at the ground station to expedite envelope exploration.

Capability #4: ***Innovative technology development within the U.S. infrastructure of suppliers and vendors:***

Maintain innovative technology development in this nation's defense material suppliers and small business engineers, consultants, and analysts. Support their abilities to invent new technologies and warfighting systems. Maximize their output by minimizing their overhead costs on DoD contracts.

Strategy #4.A: Encourage companies to develop and use preferred suppliers that are motivated to develop core competencies and innovative technologies and products.

Target incentives to suppliers in critical defense-unique sectors. Foster leveraging of technology investment dollars by - 1) removing barriers that restrict movement of technology between defense and commercial sectors, 2) change treatment of technical data to protect private sector rights, and 3) foster international co-development opportunities by ensuring that technology transfer and export control procedures are not overly restrictive.

Strategy #4.B: Foster more multi-use, multi-customer technology and product development programs.

Incentivize industry and government cooperation on multi-use, multi-customer technologies and products. Employ multiple government and industry sources to share funding for these projects; thereby reducing costs for all developers. Increase the commonality of military and commercial technologies and products.

Strategy #4.C: Streamline DoD's contracting and management practices for S&T and RDT&E to achieve better results.

Channel more DoD dollars into the hands of the scientists and engineers doing the work. Cut back on dollars spent on overhead expenses for satisfying the government's technical, financial and administrative requirements. Help small companies and suppliers direct most of the government's dollars into the hands of the technicians, engineers and fabricators, not the hands of the administrators.

Positive steps the DoD can take to achieve better results on S&T and R&D contracts are:

1) reduce bidding costs and contracting activity schedules,
2) weed out DoD programmatic requirements that affect project schedule,

3) eliminate non-value-added contractual and technical tasks (detailed schedule and cost tracking, frequent, lengthy program reviews, etc.).
4) permit task-order contracts to selected, qualified R&D and build-and-field companies and teams, and
5) permit sole-source contracts to qualified company teams and consortiums.

Throughout the DoD and NASA, a number of initiatives are underway to replace and revise the lengthy procurement process. Today's process is lengthy and expensive for both the government and industry. Often information is duplicated and converted from one information system into another, rather than using a common electronic media or data system. The challenge for the future is to move toward an all-electronic procurement process on the part of both the DoD and industry for all procurement actions while simultaneously simplifying and integrating this process to improve its timeliness and reduce the cost to all involved. (Ref 29)

Other improvements concerning process streamlining include the following: (Ref 30)

1) Good government-contractor communications early in the contracting process, prior to release of requests for proposals (RFPs):

: prior to developing the government's acquisition strategy,
: prior to releasing the draft RFP, and
: prior to releasing the final RFP.

This gets the contractor involved early. Then the company doesn't engage in "what-ifs" trying to anticipate the government's needs. They are provided with advance RFP information in order to begin structuring their bid and proposal. The company can better utilize their resources; cut down on the overhead expenses for bid and proposal and reduce their total costs for bid and proposal.

2) More contractor tailoring of the system's design and the requirements used to develop the system's design. More tailoring of the specifications and standards used as design requirements. The "Mil-Prime" concept can be used to state the government's operational and functional capability requirements in minimum terms. The contractor is permitted to develop the system specification. The contractor designs the product. Mil-Prime and specification tailoring allow the contractor to use their own processes and design.

3) More emphasis on accepting the contractor's formats and systems for documentation and data.

4) During R&D contracting, emphasize the government's desire to put the contractor's product development process on contract; not their detailed design. Put the government's functional capability requirements for the new product on contract, not the bidder's detailed design. Evaluate contractors' proposals more on process, less on design, at this step of the product acquisition.

5) During source selection, encourage proposal evaluators to perform rigorous schedule evaluations on the contractor's proposed program. Do a most-probable schedule estimate in addition to a most-probable cost estimate.

6) Contract for a RDT&E project that will be very stable for at least a year. Projects are often started on shaky footing in terms of funding, schedule, or other foundation element, which dooms them to almost immediate problems in meeting cost, schedule and/or performance requirements.

7) Apply multiyear programs more often. They provide more stability for the contractor.

8) It is very important for the government to nail down technical, schedule and operational capability and performance requirements before the program gets started and the contract gets awarded. Very important to have summit meetings with the customer (user) to solidify and coordinate requirements.

Practices to streamline the R&D contracting process are as follows: (Ref 31)

1) Keep the defense contractors involved in the contracting process and have them help the government in streamlining and improving the process. Have annual R&D Contracting Days to review and discuss contracting procedures and processes.

2) Allow the contractor's cost proposal to be submitted two weeks after submittal of their technical proposal (which typically is a 30-day response). This adds two weeks for cost proposal submission.

3) Institute a stricter interpretation of the competitive range. Usually the best technical proposals are considered within the

competitive range for further consideration. Notify the losing contractors earlier so they can disband their teams sooner.

4) Write an internal how-to guide for processing PRDA and BAA solicitations and contracts. Also design a guide for industry.

5) Make industry a part of the acquisition process team through the National Security Industrial Association (NSIA). Have the team develop a flowchart to depict the entire acquisition process for the purpose of, among other things, training of industry and government personnel. Use the NSIA as a forum for industry input to the Lab for streamlining the process.

6) Announce upcoming solicitations by putting synopses in the Commerce Business Daily up to six months ahead of the start of actions. This allows companies to better perform long-range business planning.

7) The three military Services have an initiative at the Defense Acquisition Regulation Council to standardize most clauses in R&D contracts, and to put them in the DFARS. Thus, the three Services could have standardized contracts, often cut down to six pages.

8) Issue grants to not-for-profit entities for a portion of the RDT&E budget. This provides another tool for acquiring R&D projects.

9) Take steps to improve the contractor's expenditure reimbursement rates to allow them to more quickly recoup their R&D expenditures.

Strategy #4.D: Balance competition between government and industry sources for military products and services.

Provide for strong industry participation in the overhaul, maintenance and modification work for current fielded systems. Companies need this work to help maintain their capabilities, facilities, experience, training and people. It affords opportunities to exercise multidisciplinary integrated product development and engineering, and to participate in systems-level integration, modification, and manufacturing. Although companies do not expect to make significant revenues and profits on this work, it improves their overhead cost and indirect cost bases by contributing to a higher volume of direct labor hours and materials.

As described by Mr John D. Morocco in Aviation Week and Space Technology concerning the Defense Conversion Panel: (Ref 32)

"Accelerating the integration of U.S. military and commercial technologies and increasing private sector opportunities to compete for federal research and maintenance work are two of the major recommendations of the Defense Conversion Commission."

"Providing industry with greater access to lucrative research and maintenance work is one of several recommendations in the commission's 85-page report to help defense companies weather the near-term effects of the defense drawdown. Currently, about 31% of defense maintenance and repair funding is spent in the private sector, with the remainder going to military-run depots and facilities. Shifting the ratio more toward private industry would provide defense companies with a cushion against declining procurement budgets and also help preserve "design and production capabilities beyond those of public maintenance facilities," the commission said."

As described by Mr William A. Anders, Chairman and CEO, General Dynamics Corporation: (Ref 17)

"America must rationalize both the public and private sectors of its defense industrial base. Must have a "balanced" reduction of the public and private sectors. During the Cold War, the public and private structures were balanced in capacity, supply equaled demand, and America's industrial base system was relatively efficient. Since the end of the Cold War, the decrease in DoD procurement has created excess capacity in both sectors. Consolidation is needed in both sectors to drive out excess capacity and the resulting inefficiencies. The government side of the industrial base is slowly downsizing at best, and moving to take over work traditionally done by the private sector at worst, thus further compounding the private sector excess capacity problems. Unused capacity remains in both sides of the system."

General Ronald W. Yates, Commander, Air Force Materiel Command talks about depot maintenance competition as follows: (Ref 33)

"One of our best options for maintaining a viable sustainment infrastructure is depot maintenance competition. Competition is the vehicle that can best determine the proper makeup of our organic and private industrial base."

"There are two dimensions to our competition. First, my strategy is to sustain our organic Air Force depot workload by competing for the aviation depot workload with the other services. The second dimension is to compete with industry to drive costs down. Competition gives industry the opportunity to bid on work that was previously accomplished in-house. A strategic goal is not

to use depot maintenance competition to take work away from commercial contract sources in order to stabilize our organic maintenance workforce."

"Current legislation allows us to contract out no more than 40% of our workload. That change allows industry, for the first time, to bid on $800 million in workload previously done in-house. So far, in competing for workload that was previously organic, industy has won almost a third (2 of 7). Companies that do modification/repair work are proving very competitive. However, we're finding OEMs (original equipment manufacturers) less competitive."

"Even though we want to compete everything we reasonably can, we must maintain a core organic depot capability. This core workload must be performed by an organic aviation depot, using government personnel to be responsive to the needs of our operational forces. It means retaining a flexible skill and resource base to react to changing world and industrial situations. This is necessary to provide guaranteed support for our combat forces when, for any reason, commercial contract sources cannot, or will not perform."

Strategy #4.E: Improve business and engineering practices and tools to simplify projects, cut schedules and costs, and provide higher-quality results.

Increase reliance on simulation and design tools and software (e.g., CFD, SEM) during S&T and R&D work. Use more integrated product development (IPD) and concurrent engineering techniques to shorten R&D schedules and save in overall system life cycle costs. Employ commercial product R&D practices and schedules. Use simplified technical specifications that are results-oriented, not process-oriented.

A healthy portion of the DoD's S&T dollars should be channeled into innovative design and manufacturing process tools and methods.

The DoD's technical specifications for R&D products should be primarily oriented to performance and functional capability results. They should have very minimal requirements on engineering practices, lower-tier specifications and design and construction standards, quality assurance testing, and formalized deliverable technical data.

The DoD should learn to accept the technical competency and methods of proven, successful DoD companies and suppliers, and be willing to place trust and dollars into the hands of any one of several qualified sources.

The DoD should be willing to spend extra dollars and time during the design and engineering phases of R&D programs to permit the use of IPD and concurrent engineering techniques. These will save manufacturing and support headaches and costs later, and will reduce total system life cycle costs.

The Manufacturing Development Initiative (MDI) at Aeronautical Systems Center, U.S. Air Force, Wright-Patterson AFB, OH is intended to improve the acquisition process for programs transitioning to production. A summary of the results is as follows: (Ref 34)

> The two problems identified were - 1) the inability to efficiently produce and field supportable new weapns systems, modifications, or upgrades with mature capabilities in a timely and cost-effective manner, and 2) the ability to ensure a stable, responsive industrial capability, considering both commercial and organic resources, for meeting all initial production and follow-on support. Mature capability is defined as an economically supportable system capable of sustaining all customer (user) functional requirements.
>
> The root cause of these problems is the lack of stable and controlled production process technologies needed to support manufacturing and operational use of products for the Air Force mission. Contributors are - 1) high production risk at the program start, 2) lack of attention to process capability during development, 3) lack of process control in prodution, and 4) lack of emphasis on process capability for field support.
>
> MDI consists of three parts - 1) a business strategy, 2) a set of request for proposal (RFP) guidelines, and 3) a set of guidelines and source selection criteria which define the quality management system requirements for the contract.
>
> To support rapid, low-cost prototyping and development, MDI pulls ahead tasks such as production tooling, planning and processes into the development phase. The funding profile must likewise shift, pulling some production funding into EMD.
>
> The MDI recommends certain modifications to current acquisition practices to enhance the use of the MDI technical approach. These are - 1) revision of EMD funding profiles, 2) establishing long-term supplier relationships with key suppliers early in the design process, and 3) providing the contractor with maximum flexibility to design and manufacture the product.

Clear Accountability in Design (CAID) as developed by the Air Force/Industry CAID Team (under the leadership of the Commander of Air Force Systems Command - now AFMC - and industry CEOs); resulting from the Acquisition Process Excellence (APEX) Team - 1990 is described as follows: (Ref 35)

> During its deliberations during September 1990 and August 1991, the government-industry CAID team analyzed the existing design and development process, identified areas of improvement opportunity, and established the principal causes of problems in these areas. The opportunity areas for improvement were - 1) design management, 2) risk management, and 3) effective teamwork (government-contractor) with clear roles.
>
> The problem with current design management and review was increasing government and contractor costs and schedules caused by inflexible specification management and government control of the design at the detailed solution level.
>
> CAID is used during the engineering and manufacturing development (EMD) phase of RDT&E, and permits the contractor to retain configuration control of the system/product allocated baseline and associated specifications until functional configuration audit (FCA). The government program office no longer "approves" (authenticates) lower tier performance (B) specs at preliminary design review and critical design review.
>
> The contractor must use a proven, effective configuration management system. It must comply with Military Standard 973, and must include a process to determine the impact of design changes which change the allocated requirements on the functional baseline requirements.
>
> The minimum acceptable requirements should be stated as thresholds; the rest should be objectives. Systems engineering tradeoffs should be integrated into major program milestones. Program requirements should be continually integrated and refined; program managers should be encouraged to present frank assessments. Government-industry teams should be used to help develop acquisition strategy, program requirements, etc. Clear lines of delegated authority should be established within the government's program management structure and the customer's (user's) chain of command. There should be considerable government-industry interaction in determining the application of "ilities" requirements. Incremental preliminary and critical design

reviews can be used; they should emphasize demonstration milestones and specific entry/exit criteria.

Capability #5: ***Improved program and financial management:***

Must have well-trained industry managers and financial experts (and their government counterparts) that can lead innovative, streamlined, cost-conscious multicompany and multidisciplinary teams. Use more lean, quick rapid prototyping and proof-of-concept vehicles. Develop close government-industry cooperation and teaming to share resources and maximize the return on investment. Minimize overhead costs for cost accounting, project surveillance, data generation, and other expenses.

Strategy #5.A: Train industry and government program managers to lead innovative, streamlined, cost-conscious multi-company and multidisciplinary teams.

Provide government and company training in management and engineering methods for streamlined, cost-conscious S&T and R&D projects. Foster concurrent engineering and IPD as the common approach to product and systems engineering. Foster opportunities for government and industry managers and engineers to get training and experience in their counterpart sectors.

Strategy #5.B: Remove burdens on program managers and engineers, allowing them more time to manage and focus their efforts, to be innovative, and to devote more energy to product development.

Eliminate non-value-added government overhead tasks that companies, suppliers, and their personnel must perform, such as progress tracking, cost/schedule/performance surveillance, data requirements, and financial tracking. These are cost and time burdens that should be minimized, and they detract from maximum effective utilization of project funds. The government should accept the contractor's management, financial and control systems.

Strategy #5.C: Reward innovative, effective managers, engineers and product teams.

Discourage inefficient industry practices. Challenge company teams to be innovative, cost-conscious and streamlined by using contractual performance incentives.

Strategy #5.D: Establish simple procedures to terminate RDT&E efforts; or fix deficiences in valuable, salvagable programs.

Establish simple procedures to terminate RDT&E efforts when the military user's need has evaporated, when the concept or technology is not beneficial during evaluations, or when an alternative, more cost-effective solution emerges. In order to

promote innovative R&D and the occasional development of high-risk,high-payoff concepts, there should be no stigma attached to the cancellation of R&D programs and the termination of contracts. Special procedures should govern the management of high-risk ventures.

Make it easy and quick to stop and cancel S&T and R&D projects that are in bona fide cost, schedule and/or performance trouble. Spend the time and money to fix deficiencies in valuable, salvagable programs.

Fix correctable flaws in valuable programs. Provide flexible funding and cash reserves to overcome technical headaches that are temporarily impeding healthy progress. Avoid the tendency to preserve questionable projects.

Capability #6: ***Improved contracting and acquisition processes:***

Foster shorter RDT&E timespans for developing new and improved products. Provide more competitive opportunities for company teams to participate in order to preserve their vitality. Minimize government burdens for surveillance and tracking in order to focus more dollars into direct labor results. Use incentives to reward contractors with extra profits for superior performance. Provide flexibility in technical guidance, funding and schedule requirements in order to deal with contractor's needs when problems arise.

Strategy #6.A: Reward companies for good schedule and cost performance; do not penalize honest failures or extended schedules trying to "get it right."

The government-industry working relationship needs to be improved. The current climate of distrust between the two, brought on by some egregious behavior in instances such as "Ill Wind", has resulted in legislation (e.g., Program Integrity Act of 1989) that discourages innovative and flexible management and engineering. But independently-implemented government policies and procedures have swelled, creating major obstacles to making beneficial changes to projects even when the needs are clearly evident. People now often refuse to take risks because the penalties and obstacles are so great.

To run efficient programs, government and contractor teams need to work well together with each performing its assigned tasks. A healthy dynamic tension between the teams should exist. Two recommendations are offered by the Panel as follows:

1) The government should perform balancing of requirements and design before and during a project. This activity should be monitored by the government's senior management.

2) The government should abolish regulatory practices that impede the efficiency and flexibility of government and industry RDT&E teams.

Incentivize companies to deliver quality products on-time and within predicted costs, or better. Rewards should be given for superior cost, schedule and technical performance. They can be tied to goals beyond the minimum essential requirements of the contract.

Monetary incentives in contracts should be weighted toward technical performance, rather than other measures. The company's eligibility for incentive rewards should be determined by a government technical panel rather than an administrative panel.

The product center should have flexibility (management reserve) to fund corrective actions for exigencies in good projects to get them past stumbling blocks.

Companies should be reimbursed for all incurred costs, regardless of the project's outcome. The government should not expect companies to help accomplish early analyses and tradeoff studies without covering these costs.

The government's contracts should fairly reflect the risks the parties are being asked to assume; not what they are willing to take a chance on. Most government contracts explain in great length the government's rights and the contractor's obligations. The government assumes little risk for the successful outcome of the work effort. During past large defense budgets, contractors were willing to take risky contract positions. Today, however, companies' shareholders may insist that they refuse to bid on high-risk contracts. They may want the company to preserve its capital, even though lower sales may result. Everything in the defense aircraft business was turned on its head on January 7, 1991 when the A-12 program was terminated for default. Nothing has happened in recent years that has concentrated the mind of this industry as much as has that termination. It is doubtful that aircraft manufacturers today would bid any program as fraught with risk as was the A-12 program when it started EMD in late 1986. (Ref 36)

In the past, government contract administrators have refused to negotiate and definitize major contracts in advance of doing the bulk of the work (e.g., in some cases, 65% of the contractor's costs may already be incurred, and all major procurements may already have been definitized.). As a result, any contract is then largely based on costs already incurred, and the incentive to perform at low cost in order to maximize profits has been lost. Incentives must be structured and followed permitting companies to control their own destinies. They should be definitized before starting the work. Then companies can plan their programs for accomplishment at lowest cost, earning them the highest profit.

Strategy #6.B: <u>Award more short-term projects rather than few lengthy, costly programs.</u>

Companies supporting the DoD's product centers need a steady flow of profitable projects to maintain their capabilities. The Panel's design-build-field strategy recommends a high rate of mission need study contracts, CE&D studies, Dem-Vals and EMDs each year. To implement new DoD and national policies and strategies for continuing technology development and improvement of our warfighting machinery in an era of reduced defense budgets, it will be increasingly important to steer away from the old paradigm of sustaining lengthy, costly RDT&E tied to commitments for large production runs.

The Panel recommends fielding small fleets of upgraded and new systems in order to field new technology capabilities. These programs exercise the full range of company capabilities, from technology development and innovative design to manufacturing and product support.

Strategy #6.C: **Balance competition with cooperation.**

The DoD's competition rules should be revised as necessary to permit more beneficial teaming of companies while maintaining competition where it truly influences costs.

Product centers and laboratories should have the ability to direct work to certain companies and entities in order to take advantage of highly desirable and successful work. Qualified sources for product development can be established, and task order contracts can be used.

In line with the Panel's strategy, product centers must have the freedom at each new phase of a product development to downselect from the most highly successful and desirable results and companies of the prior phase. Selecting a qualified, competent company or source should be straightforward and simple, and should not require a full and open competition that "rebaselines" the entire R&D effort. A set of preferred suppliers should be used by the product center; each supplier having the competency and successful track record to perform a particular type of project.

Strategy #6.D: **Minimize contractor's overhead costs.**

Reduce industry's and government's overhead expenses for management, administration, cost-schedule-performance surveillance, formalized deliverable data, technical and program reviews and meetings, and approval processes. Rely on company's proven track record to deliver high-quality, successful products.

Minimize company's up-front expenses incurred during bid and proposal cycles and detailed cost and contract audits.

Suggestions for reducing overhead costs on DoD contracts provided by the Business Group of the ASC Manufacturing Development Initiative (MDI) are as follows: (Ref 37)

: Reduce oversight and reviews.
: Eliminate flow-down of contract clauses to commercial suppliers.
: Expand electronic data exchange - reduce the volume of data.
: Eliminate work measurement requirements and other Mil-Stds specifying how the contractor performs his work.
: Implement environmental programs smartly.
: Reduce socio-economic programs.
: Reduce plans and proposal documentation.
: Implement long-term supplier relationship business solutions.

: Reduce other overhead drivers, such as - 1) DCAA defective pricing reviews on small dollar values, 2) compliance training reporting, 3) CORE/PAR reviews, and 4) timely negotiations and contract closeouts.

9. REFERENCES

1. Streamlining Defense Acquisition Laws, Executive Summary: Report of the DoD Acquisition Law Advisory Panel, March 1993, Defense Systems Management College Press.

2. Remarks by Secretary of Defense Les Aspin; Armed Forces Welcoming Ceremony, February 1, 1993.

3. Tomorrow's Defense From Today's Industrial Base: Finding the Right Resource Strategy For A New Era, Rep. Les Aspin, Chairman - House Armed Services Committee (now Secretary of Defense), 12 February 1992.

4. Report, Industrial Base Strategy - Report of Aeronautical System Acquisition Industrial Base Off-Site, 3-4 December 1992, ASC/XR, Wright-Patterson AFB, OH.

5. Speech to the Dayton Growth Association by General Ronald W. Yates, Commander, Air Force Materiel Command, 12 March 1993.

6. Air Force Planning Guidance; FY95 Amended Budget Estimate Submission; 13 August 1992.

7. Congressional Budget Office Paper, An Analysis of the President's February Budget Proposals, March 1993.

8. Keynote speech by General John M. Loh, Air Warfare Symposium, Orlando, FL, 4 February 1993.

9. Briefing, *Development Planning,* John M. Griffin, ASC/XR, Wright-Patterson AFB, OH, April 1993.

10. Mr Greg Nelson, ASC/FMBM, Wright-Patterson AFB, Ohio, January 1993.

11. From Lockheed Fort Worth Company, October 1992.

12. Report R-4199-AF, Maintaining Future Military Aircraft Design Capability, RAND, 1992.

13. Westinghouse Electric Corporation, *Defense Industry Consolidation - Business Planning,* August 26, 1992.

14. Booz Allen & Hamilton, March 1992.

15. Prudential Securities, April 30, 1992.

16. Prudential Securities, May 26, 1992.

17. Speech, "Revisiting the Rationalization of America's Defense Industrial Base - Ensuring Public and Private Sector Efficiency and Adequacy for Future National Security," by William A. Anders, Chairman and CEO, General Dynamics Corporation to the Aerospace Industries Association Human Resources Council, 27 October 1992.

18. Notes from Mr Ewing's briefing to the Working Panel, 5th Panel Meeting, 14 January 1993, Lockheed Forth Worth Company, Fort Worth, TX.

19. Excerpts from "Can We Plan the U.S. Defense Industrial Capital Stock?" by Professor David Blair, Air War College, date unknown (est 1993).

20. Excerpt from "The State of U.S. Manufacturing: An Annual Report," FOCUS, National Center for Manufacturing Sciences, January 1993.

21. Excerpt from "American Manufacturers No Longer Provide the Industrial Benchmark for the World," FOCUS, National Center for Manufacturing Sciences, January 1993.

22. Excerpt from "U.S. Manufacturers Give Themselves a "C", Admit They Have Substantial Work To Do," FOCUS, National Center for Manufacturing Sciences, January 1993.

23. *Civilian/Military Integration*, Jacques S. Gansler, The Analytical Sciences Corp, 21 January 1993.

24. Commercial Aircraft Acquisition Critical Process Team Report, ASC/SDC, Wright-Patterson AFB, OH, 4 June 1993.

25. ASC/SDE, Wright-Patterson AFB, OH, 7 July 1993.

26. Mr Robert E. Morris, General Electric Aircraft Engines, Cincinnati, OH.

27. Hypersonic Test Investment Plan, May 1993.

28. Mr Frank M. Rafchiek, Boeing Company, Military Airplanes Division, Seattle, WA.

29. Informal Memo, "Improvements in USAF-Industry Business Policies and Practices - Electronic Procurement," Mr John Steurer, McDonnell Douglas Aerospace - East, 8 February 1993.

30. Mr. John Artuso, ASC/CYX, Aeronautical Systems Center, Wright-Patterson AFB, OH, January 1993.

31. Ms Kathy Plowman, Contract Review and Policy Division (WL/PKC), and Mr Mike Weaver, WL,FIK, Wright Laboratory, Wright-Patterson AFB, OH, January 1993.

32. Article; "Defense Conversion Panel Urges Dramatic Changes," John D. Morrocco, Aviation Week & Space Technology, January 25, 1993.

33. Speech to the NAECON Plenary Session by General Ronald W. Yates, Commander, Air Force Materiel Command, 25 May 1993.

34. Draft Report, Manufacturing Development Initiative (MDI), Aeronautical Systems Center, Wright-Patterson AFB, OH, 2 October 1992.

35. Final Report, Government/Industry Acquisition Process Review Team Clear Accountability in Design, Aeronautical Systems Center, Wright-Patterson AFB, OH, October 1991.

36. Memo, "How A Change in Contracting Techniques Might Help Produce A More Robust Contracting Establishment," J.D. Slack, Lockheed Fort Worth Company, 21 August 1992.

37. Input to the Secretary of Air Force-commissioned "Overhead Cost Analysis Review" Study Group (including Ms Donna Back, ASC/FM and Brig Gen Nauseef, AFMC/FM) from Mr Bill Kugel, ASC/FMC, Aeronautical Systems Center, Wright-Patterson AFB, OH, January 1993.

10. APPENDIX: STATISTICS

1. 100 Years of Defense Spending (Constant FY82 $$ billions per year): (ref: Lockheed Fort Worth Co.)

: Peak Years	1920	WW1	$200 billion	17%	GNP
	1945	WW2	$600	39%	
	1954	Korea	$280	14%	
	1970	Vietnam	$260	9%	
	1989	Reagan	$250	7%	
: Low Years	1900-18		$20-30 billion	2%	
	1922-1942		$50-70	2-3%	
	1949		$50	4%	
	1977-78		$180	5%	

2. Air Force Total Obligation Authority (TOA): (ref: USAF TOA Budget History, National Defense Budget Estimates for 1993; FY93 $$ billions)

: Peak Years	1958	$110 billion
	1963	$110
	1967	$112
	1985	$125
: Low Years	1975	$70 billion
	1979	$65 billion

3. Air Force RDT&E budgets (FY92 $$ billions): (ref: Lockheed Fort Worth Co.)

1961-64	approx $15-20 billion/yr
1965-68	approx $12-13 billion/yr
1970-80	approx $7-10 billion/yr
1985-89	approx $14-18 billion/yr
1991-92	approx $12-13 billion/yr

4. Estimated demonstrator aircraft costs (FY92 $$ millions): (ref: Lockheed Fort Worth Co.)

: ATTT	$3	million	: XV-15	$60	million
: Have Blue	$100	million	: Model 360	$250	million
: YA-10A	$267	million	: YF-16	$305	million
: YC-14/15	$602	million	: YF-22/23	$1502	million

5. DoD Aircraft New Starts by Platform (1960-1995): (ref: Lockheed Fort Worth Co.)

1960-1964	Tactical	USAF= F-111A, F-5A	2
	Cargo/Tnkr	USAF = C-141A	1
	Electronic	USAF = RF-4C	1
1965-1969	Tactical	USAF= F-15A	1
		USN= A-7D, A-6E, P-3C, S-3A, F-14A	5
	Bomber	USAF= FB-111	1
	Cargo	USAF= C-5A	1
	Electronic	Navy = E-2C, EA-6B	2
	Trainer	Navy = T-2C	1
1970-74	Tactical	USAF= F-16A	1
	Bomber	USAF= B-1	1
	Electronic	USAF= E-3A, E-4, EF-111	3
	Trainer	USAF= T-34C	1
		Navy = T-44A	1
1975-79	Tactical	USAF = F-117	1
		Navy = F/A-18, AV-8B	2
	Cargo/Tnkr	USAF = KC-10, KC-135R	2
	Electronic	USAF = TR-1	1
1980-84	Tactical	USAF = F-15E	1
		Navy = F-14D	1
	Bomber	USAF = B-2	1
	Cargo/Tnkr	USAF = C-17, C-5B	2
	Electronic	Navy = EA-8, E-6A	2
	Trainer	USAF = T-46	1
		Navy = T-45	1
	Other	USAF = V-22	1
1985-89	Tactical	Navy = A-12, P-7	2
	Trainer	USAF = T-1	1
1990-94	Tactical	USAF = F-22	1
		Navy = F/A-18E/F	1

: In 35 years, 18 tactical aircraft new starts, with USAF = 7, Navy = 11.
: In 35 years, 3 bomber aircraft new starts, with USAF = 3.
: In 35 years, 6 cargo/tanker aircraft new starts, with USAF = 6.
: In 35 years, 9 electronic aircraft new starts, with USAF = 4, Navy = 5.
: In 35 years, 6 trainer aircraft new starts, with USAF = 3, Navy = 3.
: In 35 years, 1 other aircraft new start (V-22), with USAF = 1.
: Peak activity periods were 1965-1969, with 6 fighters, 1 bomber, 1 cargo, 2 electronic, and 1 trainer; equals 11 aircraft in 5 years. Also, 1980-1984, with 2 fighters, 1 bomber, 2 cargo, 2 electronic, 2 trainer, and 1 other; equals 10 aircraft in 5 years.
: Worst periods were 1960-1964 with 4 aircraft, and 1985-1989 with 3 aircraft.

6. Analysis of Aeronautical Systems Center FY93 President's Budget as of 1 October 1992; as derived from the ASC Statistical Digest, 1 October 1992:

a. Of the USAF's total TOA of $84.2 billion, AFMC gets $30.8 billion (37%).
: ASC gets $14.5 billion (47%) of the AFMC budget.
: Of ASC's budget of $14.5345 billion:

WL	= $720.5 million	= 5%
645 ABW	= $1.3931 billion	= 9.6%
4950TW	= $56.4	= 0.4%
ASC, Eglin	= $1681.9	= 11.6%
Med Center	= $14.1	= 0.01%
Functionals: (FM, EM, EN)	= $395.9	= 2.7%
Acquis SPOs:	= 11665.7	= 80.3%

: Percentage breakdown by office and program of ASC $14.5345 billion:

: 6.3 S&T	NA	= 175.5	= 1.2%
: EW & Recce	RW	= 233.7	= 1.6%
: Acft SPO (cargo, trnr, gen'l)	SD	= 666.2	= 4.6%
: Subsystems	SM	= 183	= 1.3%
: Adv Cruise Missile	VC	= 82.3	= 0.6%
: F-15	VF	= 93.5	= 0.64%
: LANTIRN	VL	= 30.4	= 0.2%
: Dev Planning	XR	= 23.6	= 0.2%
: C-17	YC	= 2929.5	= 20.2%
: F-22	YF	= 2224.3	= 15.3%
: F-16	YP	= 867	= 6%
: B-2	YS	= 3948	= 27.2%
: Trainers, simulators	YT	= 208.7	= 1.4%

b. Of ASC's total budget of $14.5345 billion, 3600 RDT&E = $6.0083 billion (41.3%):

= mission =	$ 5.7934 billion	(39.9%)
= support =	0.2149	(1.5%)
3010 Acft Procur =	6.9021	(47.5%)
3020 Missile Proc =	1.0804	(7.4%)
3080 Other Proc =	0.01243	(0.9%)
3400 O&M =	0.4194	(2.9%)

c. Including FMS sales, ASC's total budget is $23.1 billion:

: AFMC budget share	= $14.5 billion	(62.8%)
: FMS sales	= $8.6	(37.2%)

d. 90.5% of ASC's FY92 contract dollars of approximately $15.2 billion was obligated to the following Top-20 contractors (in FY92, the ASC total budget was $24.8 billion, with $18.6 billion from AFMC and $6.2 billion from FMS sales) (therefore, $13.75 billion went to the Top-20 contractors, which is 74% of ASC's share of the AFMC budget of $18.6 billion, or 55.5% of ASC's total budget of $24.8 B):

: Northrop	$4474.4 million	(29.4% of approx $15.2 billion obligated)
: Lockheed	$2407.6 million	(15.8%)
: General Dynamics	$1737.8 million	(11.4%)

: McDonnell-Douglas $1395.5 million (9.2%)
: etc.

e. Of its total FY93 budget of $23.1 billion including FMS sales, ASC spends only $23.6 million on development planning, or 0.1%.

f. In FY93, ASC will spend $2.7919 billion on RDT&E of SAR-level programs. This is 48% of ASC's RDT&E budget of $5.7934 billion.